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# U.S. Army Land Condition-Trend Analysis (LCTA) Plot Inventory Field Methods

by
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This report outlines standard methods for collecting and maintaining a permanent LCTA data base on the condition of Army land resources. Included are lists of equipment needed for data collection, and detailed procedures for establishing permanent field plots, collecting plant specimens, inventorying wildlife populations, and maintaining the data bases by periodic short- and long-term monitoring of the field plots.

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## FOREWORD

The LCTA field procedures outlined in this report were developed at the request of the U.S. Army Engineering and Housing Support Center (USAEHSC), Fort Belvoir, VA, under Funding Acquisition Document (FAD) No. 89-080046, "Land Condition-Trend Analysis." The technical monitor was Mr. Donald M. Bandel (CEHSC-FN).

Research leading to the LCTA methods was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (USACERL). The USACERL principal investigator was Victor E. Diersing. Thanks are given to the several researchers, field crew leaders, and technical assistants who contributed to the success of the LCTA program by helping to refine the methods, including USACERL personnel Mr. Timothy Blechl, Mr. Jeffrey Courson, Mr. Paul Dubois, Mr. Keith Harris, Dr. David Price, and Mr. V. Lyle Trumbull; and Colorado State University (CSU) personnel Ms. Christine Gordon, Mr. Eamon O'Regan, Ms. Dana Quinney, Mr. Keith A. Schulz, and Mr. Gene Weglinski. Ms. Chris M. Bern, of CSU, and Ms. Cynthia Abrahamson, Mr. David Kowalski, and Mr. William Sprouse, of USACERL contributed to development of LCTA standardized analyses and reporting procedures. Special thanks are given to Mr. Dennis Herbert, of Fort Hood and Mr. Thomas Warren, of Fort Carson, who cooperated extensively in the preliminary development of the LCTA methods. Dr. E.W. Novak is Acting Chief, USACERL-EN. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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# U.S. ARMY LAND CONDITION-TREND ANALYSIS (LCTA) PLOT INVENTORY FIELD METHODS

## 1 INTRODUCTION

### Background

The U.S. Army Land Condition-Trend Analysis (LCTA) program was developed at the U.S. Army Construction Engineering Research Laboratory (USACERL) under the sponsorship of the U.S. Army Engineering and Housing Support Center (USAEHSC). LCTA uses standard methods to collect, analyze, and report natural resources data, and is the Army's standard for land inventory and monitoring.[1] It is a major component of the Integrated Training Area Management (ITAM) program, also developed at USACERL. The three other components of ITAM include: (1) Environmental Awareness, (2) Land Rehabilitation and Maintenance, and (3) Training Requirements Integration.

LCTA promotes the principles of sustained yield, land stewardship, and multiple use of military land resources. The major objectives of LCTA are to: (1) evaluate the capability of land to meet the multiple-use demands of the U.S. Army on a sustained basis, (2) delineate the biophysical and regulatory constraints to use of the land, (3) monitor changes in land resource condition and evaluate change in terms of current land use, (4) develop and refine land management plans to ensure long-term resource availability, (5) characterize installation natural resources, and (6) implement standards in collection, analysis, and reporting of the acquired data that enable Army-wide data compilation.

Development and Army-wide implementation of the LCTA program has been driven by four major factors: the Army's unique land management challenge, the need for sufficient training land, recommendations of natural resource experts, and environmental compliance requirements.

*The Unique Land Management Challenge*

The U.S. Army is responsible for managing 12.4 million acres of land on 186 major installations world-wide.[2] While many of these lands are used for a variety of military training and testing activities, they also are managed for many nonmilitary uses, including fish and wildlife, forest products, recreation, agriculture, and grazing. Proper land management supports the military mission and multiple use activities, but also presents the Army with a unique challenge as public land steward. Furthermore, Army installations span all North American ecoregions and habitat types, yielding a complex and diverse management challenge.

[1] Technical Note 420-74-3, *Army Land Inventory and Monitoring Procedures on Military Installations* (U.S. Army Engineering and Housing Support Center [USAEHSC], Fort Belvoir, VA, 1990).

[2] U.S. Department of the Army (DA), *Facilities Engineering and Housing Annual Summary of Operations, Fiscal Year 1989* (Office of the Assistant Chief of Engineers [OACE], USAEHSC, 1989).

*Training Land Needs*

The land area available to the Army is inadequate to meet existing training mission requirements.[3] This is a result of the need for more area to test and train personnel in the use of modern weapon systems. The area now necessary to train a division is roughly 10 times that needed for training comparable units in the mid-1940s.[4] Furthermore, increased use of training lands in recent years has led to reports of a general deterioration in the condition of the U.S. Army's natural resources.[5]

*Expert Recommendations*

In the spring of 1984, the U.S. Army convened an independent panel of natural resources experts to evaluate and recommend changes to natural resource management programs on selected military installations and civil works projects.[6] The panel included experts in range science, wildlife management, and forestry. Among the 12 recommendations, four were to form the basis for development of standard inventory procedures for Army lands: (1) match training loads with land capabilities, (2) base land management plans on current resource inventories and monitoring procedures, (3) require natural resource inventories on all military installations, and (4) establish personnel at each military installation to minimize soil erosion and manage vegetation resources.

*Environmental Compliance*

The Army must comply with a variety of environmental regulations based on such legislation as the National Environmental Policy Act, the Endangered Species Act, and the Clean Water Act.[7] Compliance requires a detailed record of the status of natural resources as well as change in response to land use over time. Furthermore, the Secretary of Defense has called upon the military to be the leader in environmental compliance and natural resource management.[8] And, the commanding general of the U.S. Army Corps of Engineers stated that the Corps' service to the military should be measured by the Corps' success in environmental leadership and a commitment to go "beyond compliance" with environmental laws.[9]

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3 Training Circular (TC) 25-1, *Training Land* (DA, Washington, DC, 1978).

4 TC 25-1.

5 V.E. Diersing and W.D. Severinghaus, *The Effects of Tactical Vehicle Training on the Lands of Fort Carson, CO—An Ecological Assessment*, Technical Report (TR) N-85/03/ADA152142 (U.S. Army Construction Engineering Research Laboratory [USACERL], December 1984); W.D. Goran, L.L. Radke, and W.D. Severinghaus, *An Overview of the Ecological Effects of Tracked Vehicles on Major U.S. Army Installations*, TR N-142/ADA126694 (USACERL, February 1983); F.L. Johnson, "Effects of Tank Training Activities on Botanical Features at Fort Hood, Texas," *Southwest Naturalist* No. 27 (1982), pp 309-314; D.J. Schaeffer et al., TR N-86/22/ADA174502, *Preliminary Study of Effects of Military Obscurant Smokes on Flora and Fauna During Field and Laboratory Exposures* (USACERL, 1986); W.D. Severinghaus and W.D. Goran, TR N-116/ADA111201, *Effects of Tactical Vehicle Activity on the Mammals, Birds, and Vegetation at Fort Lewis, Washington*, (USACERL, November, 1981); W.D. Severinghaus, R.E. Riggins, and W.D. Goran, TR N-77/ADA073782 *Effects of Tracked Vehicle Activity on Terrestrial Mammals, Birds and Vegetation of Fort Knox, KY* (USACERL, July 1979).

6 L.R. Jahn, C.W. Cook, and J.D. Hughes, *An Evaluation of U.S. Army Natural Resource Management Programs on Selected Military Installations and Civil Works Projects* (Unpublished) Report to the Secretary of the Army, U.S. Department of the Army (1984).

7 M. Donnelly and J.G. Van Ness, "The Warrior and the Druid--DOD and Environmental Law," *Federal Bar News and Journal*, Vol 33, No. 1 (1986), pp 37-43.

8 R. Cheney, Memorandum for Secretaries of the Military Departments. Subject: Environmental Management Policy (Washington, DC, 10 October 1989).

9 LTG H.J. Hatch, Memorandum, Subject: Strategic Direction for Environmental Engineering (Headquarters, U.S. Army Corps of Engineers [HQUSACE], Washington, DC, 14 February 1990).

Preliminary development of LCTA field methods began in the summer of 1984 at Fort Carson, CO and Fort Hood, TX. After evaluation and refinement of techniques in the fall and winter of 1984, a pilot implementation program was begun at the Piñon Canyon Maneuver Site, CO and expanded at Fort Carson and Fort Hood. A workshop was held at Fort Hood, TX in May of 1987 to review progress in program development, obtain input from installation natural resource personnel concerning the usefulness of the information, and make plans for implementation on other installations. In 1987, USAEHSC recommended Army-wide implementation.

Review of the LCTA program by the U.S. Army Land Inventory Advisory Committee found that the methods were technically sound, and that the information generated had applications for land managers and trainers, environmental compliance documentation, and land acquisition evaluation. The committee also reported that it would be less costly to implement the program than to restore training land resources lost or damaged through noncompliance.[10]

The LCTA program has the support of the Assistant Secretary of the Army[11] as well as a variety of organizations including the National Military Fish and Wildlife Association[12] and the Defense Natural Resources Council.[13] Over 50 military installations and training areas in the United States and Germany have begun or plan to implement the program (Figure 1 shows thirty-nine of these). Fort Carson, one of the first locations to implement LCTA, recently won the National Wildlife Federation's National Conservation Achievement Award,[14] and Fort Sill won the 1989 DOD Natural Resources Conservation Award with the help of the ITAM and LCTA programs.[15]

Part of the success of the LCTA program is due to its systematic approach to land management, and commitment to careful collection and maintenance of land condition-trend data over time. To begin a land condition-trend analysis, Army installation resource personnel must first establish core plots and a standardized system for gathering and analyzing data, which will be maintained as a permanent data base.

## Objective

The objective of this report is to describe standard methods to establish LCTA field plots; collect data on soils, vegetation, and wildlife; and maintain that data for short- and long-term use.

## Approach

The LCTA plot inventory employs standard methods, permanent field plots, stratified random sampling, and emphasizes multiple applications of the data collected.

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[10] U.S. Army Land Inventory Advisory Committee, *Report of LCTA Review* (Washington, DC, 1989).

[11] J.W. Shannon, Memorandum for Director of the Army Staff. Subject: Land Management—Action Memorandum (Washington, DC, 18 August 1987).

[12] National Military Fish and Wildlife Association, "Resolution 2—Military Land Inventory and Monitoring," *Fish and Wildlife News*, Vol 5, No. 2 (1988).

[13] C. Ramsey, Memorandum for Deputy Director, Defense Research and Engineering. Subject: Training Area Management Technology (Washington, DC, 1 March 1989).

[14] U.S. Army Engineering and Housing Support Center (USAEHSC), "Fort Carson Wins National Conservation Achievement Award," *DEH Digest*, Vol 2, No. 3 (Fort Belvoir, VA, 1989), p 28.

[15] P. Schmitt, "Corps Program Helps with Award for Fort Sill," *Engineer Update*, No. 14 (1990).


Figure 1. U.S. Military Installations That Have Begun or Plan To Implement Land Condition-Trend Analysis.

Standard data collection and recording methods are summarized to allow Army-wide data comparability, and to enable data summary at MACOM and DA levels, and database system compatibility. This also minimizes system development and maintenance costs. Such standardization also helps lessen the negative effect of turnover of Army natural resources management personnel, minimizes program training needs, and creates a common natural resources language.

Procedures are given for establishing permanent field plots to quantify the condition of and trends in installation natural resources. Permanent plots are advantageous in regard to both cost and the power of statistical analysis. Time and labor are saved by allowing a return to the same location each year thus avoiding the need to reestablish sample plots annually. Statistical analyses are made more effective by eliminating variability in the data attributable to spatial variation, thus facilitating the detection of trends. This reduces the total number of plots necessary to determine trends, resulting in additional cost savings. Data are collected on soils, slope, aspect, surface disturbance, vegetation cover, botanical composition, wildlife, and land use.

The procedures were designed to include random sampling, which allows statistical inferences to be made based on the data collected, and permits characterization of installation natural resources as a whole. Sampling is stratified on the basis of soils and land cover types (derived from satellite imagery), facilitating analysis of natural resource status and land capability by those spatial elements.

The ability to derive multiple interpretations of the data has been a foremost consideration throughout the development and implementation of LCTA. The data can be used to quantify land use, ground cover, and surface disturbance,[16] allowable use and carrying capacity,[17] tactical concealment, soil stability and soil erosion,[18] land rehabilitation effectiveness,[19] plant community composition wildlife populations and habitats,[20] and endangered species habitats.[21] It can also be used to ground-truth geographic information system and satellite imagery data.[22]

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[16] R.B. Shaw and V.E. Diersing, "Tracked Vehicle Impacts on Vegetation at the Piñon Canyon Maneuver Site, Colorado," *Journal of Environmental Quality*, No. 19 (1990), pp 234-243; R.B. Shaw et al., "U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii," *Proceedings of the International Symposium on Tropical Hydrology* (American Water Resources Association, Bethesda, MD, 1990), pp 455-46.

[17] V.E. Diersing, R.B. Shaw, S.D. Warren, and E.W. Novak. "User's Guide for Estimating Allowable Use of Tracked Vehicles on Non-Wooded Military Training Lands," *Journal of Soil and Water Conservation*, No. 43 (1988), pp 191-195; R.B. Shaw and V.E. Diersing, "Allowable Use Estimates for Tracked Vehicular Training on Piñon Canyon Maneuver Site, Colorado, USA," *Environmental Management* , No. 13 (1989), pp 773-782.

[18] S.D. Warren, V.E. Diersing, P.J. Thompson, and W.D. Goran, "An Erosion-Based Land Classification Scheme for Military Installations," *Environmental Management*, No. 13 (1989), pp 251-257.

[19] R.B. Shaw and V.E. Diersing, Unpublished Report, *Evaluation of Pitting and Seeding on the Piñon Canyon Maneuver Site, Colorado* (USACERL, 1987).

[20] D.J. Tazik, W.R. Whitworth, and V.E. Diersing, "Using the LCTA Relational Database for Plant Community Classification and Wildlife Management," Abstract presented at the Annual Meeting of the American Society of Agronomy, Las Vegas, NV (1989).

[21] K.A. Schulz, R.B. Shaw, and D.J. Tazik, "Status of *Haplopappus fremontii* A. Gray subsp. *monocephalus* (A. Nels.) H. M. Hall (*Asteraceae*) on the U.S. Army Piñon Canyon Maneuver Site, Colorado, *Phytologia* (submitted for publication, 1991).

[22] S. Ribanszky, Draft TR, *Monitoring Vegetation Change With SPOT Satellite Imagery* (USACERL, December 1990).

**Mode of Technology Transfer**

It is recommended that LCTA be incorporated into Army Regulation (AR) 420-74, *Natural Resources–Land, Forest, and Wildlife Management*, which is currently under revision. The U.S. Army Engineering and Housing Support Center (USAEHSC) sponsors annual LCTA training workshops, conducted by USACERL staff, for Army Resource Management personnel.

## 2 FIELD PLOT ESTABLISHMENT

The standard size of the LCTA permanent plot is 100 x 6 m with a 100-m line transect forming the longitudinal axis. The elongated, rectangular plot shape is preferred because it exhibits lower variance and greater sampling efficiency compared to other shapes,[23] and tends to include more species than plots with a lower perimeter to area ratio.[24] Land use is recorded on each plot, and woody plants are recorded to provide density estimates and document trends in tactical and wildlife cover. The line transect is used to quantify ground cover, canopy cover, and surface disturbance. Wildlife data are collected at a subsample of these plots.

### Core Plots

Core plots are used to evaluate the condition of natural resources on the installation, and serve as the basis for the national inventory, including MACOM and DA summaries. They are located in an objective, random manner, to ensure that the data are representative of the installation as a whole.

#### *Placement of Core Plots*

Core plot locations are chosen using an automated site selection process designed to ensure objectivity, randomness, and representation.[25] The procedure incorporates SPOT (Systeme Probatoire pour l'Observation de la Terre) satellite imagery,[*] digital soil surveys, and the Geographic Resources Analysis Support System (GRASS) geographic information system (GIS). The first step is to acquire satellite imagery for the installation. The date of the imagery should correspond to peak phytomass. An unsupervised classification is performed on the image allowing the selection of up to 20 landcover categories based on reflectance values in the green, red and near infrared wavelength bands. These bands are among the best for distinguishing differences in plant biomass, cover, and species composition.[26]

Within GRASS, the resulting landcover data layer is superimposed on a digital soil survey of the area. Each unique landcover/soil combination is recognized as a separate category, and the occurrence of each landcover/soil combination, called a polygon, is identified. Polygons of less than 2 hectares are eliminated because, in practice, they are difficult to locate in the field.

Core plot locations are selected using a procedure that assigns plots randomly to the array of all polygons that comprise each landcover/soil category, resulting in a random stratification by soil and land cover type. The number of plots assigned to each category is proportional to the land area included in each. For example, a landcover/soil category covering 10 percent of the installation would receive 10 percent of the plots. This procedure helps ensure that the data collected are representative of the

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[23] C.W. Cook and J. Stubbendieck, eds., *Range Research: Basic Problems and Techniques* (Society for Range Management, Denver, CO, 1986).

[24] C.D. Bonham, *Measurement of Terrestrial Vegetation* (John Wiley & Sons, New York, 1989).

[25] S.D.Warren, M.O. Johnson, W.D. Goran, and V.E. Diersing, "An Automated, Objective Procedure for Selecting Representative Field Sample Sites," *Photogrammetric Engineering and Remote Sensing*, No. 56 (1990), pp 333-335.

[*] LANDSAT imagery also may be used. On small installations, available aerial photography may be used, in which case land cover is delineated manually.

[26] J.R. Jensen, *Introductory Digital Image Processing* (Prentice-Hall, Englewood Cliffs, NJ, 1986).

installation as a whole. Field crews are provided with plastic overlays registered to U.S. Geologic Survey (USGS) 7.5-minute quadrangle maps. The overlays are color-printed with all eligible polygons. Large symbols identify the locations of the core plots (Figure 2). The field crews are responsible for establishing the plots as near as possible to the locations identified on the overlays. Global positioning systems, which triangulate signals from satellites, are useful in areas where landmarks are scarce. When a plot location is inaccessible, the field crew leader may substitute a comparable location that has the same landcover/soil combination and similar aspect and slope.

*Number of Core Plots*

The number of core plots established at any given installation should be based on the size and variability of the area. Unfortunately, variability is difficult to evaluate prior to field sampling. As a rule of thumb, there should be approximately one plot per 200 hectares. For large installations, where this results in an unmanageable number of plots, a limit of 200 core plots is suggested. This is about as many plots as two field crews can establish and inventory during a single field season.

**Special Use Plots**

As the name implies, special use plots are for use in special situations. They do not comprise part of the national inventory and should be excluded when making installation-wide evaluations of land condition. Special use plots are used to deal with specific issues that cannot be addressed by core plots—determining the success of land rehabilitation efforts, documenting the effects of burning, assessing natural recovery of degraded lands, characterizing and monitoring habitat of threatened and endangered species and wetlands, etc.

Special use plots can be used as control plots if they can be placed in areas that receive little or no military impact. Such plots can be used to differentiate changes documented on core plots caused by land uses and environmental factors. There is no rule for determining the number of control plots. On some military installations, it may be difficult to find unused areas.

**Plot Establishment**

Once the plot has been located in the field, the line transect is established with the beginning point set as close as possible to the Universal Transverse Mercator (UTM) coordinates provided. Table 1 lists equipment needed to establish permanent plots. The beginning point is marked with a threaded 0.5-in.* interior diameter pipe with a 3.5-in. floor flange attached to the top. The flange serves to make the pipe easier to locate with a metal detector. The length of the stake is approximately 0.5 m, but may be shorter in areas with shallow soil.

A small, 5 to 8-cm deep depression is dug and the pipe driven into the ground until the flange is flush with the bottom of the depression (Figure 3). Another pipe is placed on the center of the floor flange and struck with the hammer to avoid breaking the flange. A steel rod is then driven through the center of the pipe until about 2 cm remains above the soil surface. The depression is refilled so that only the top of the rod is visible.

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* A metric conversion table is included on p 60.

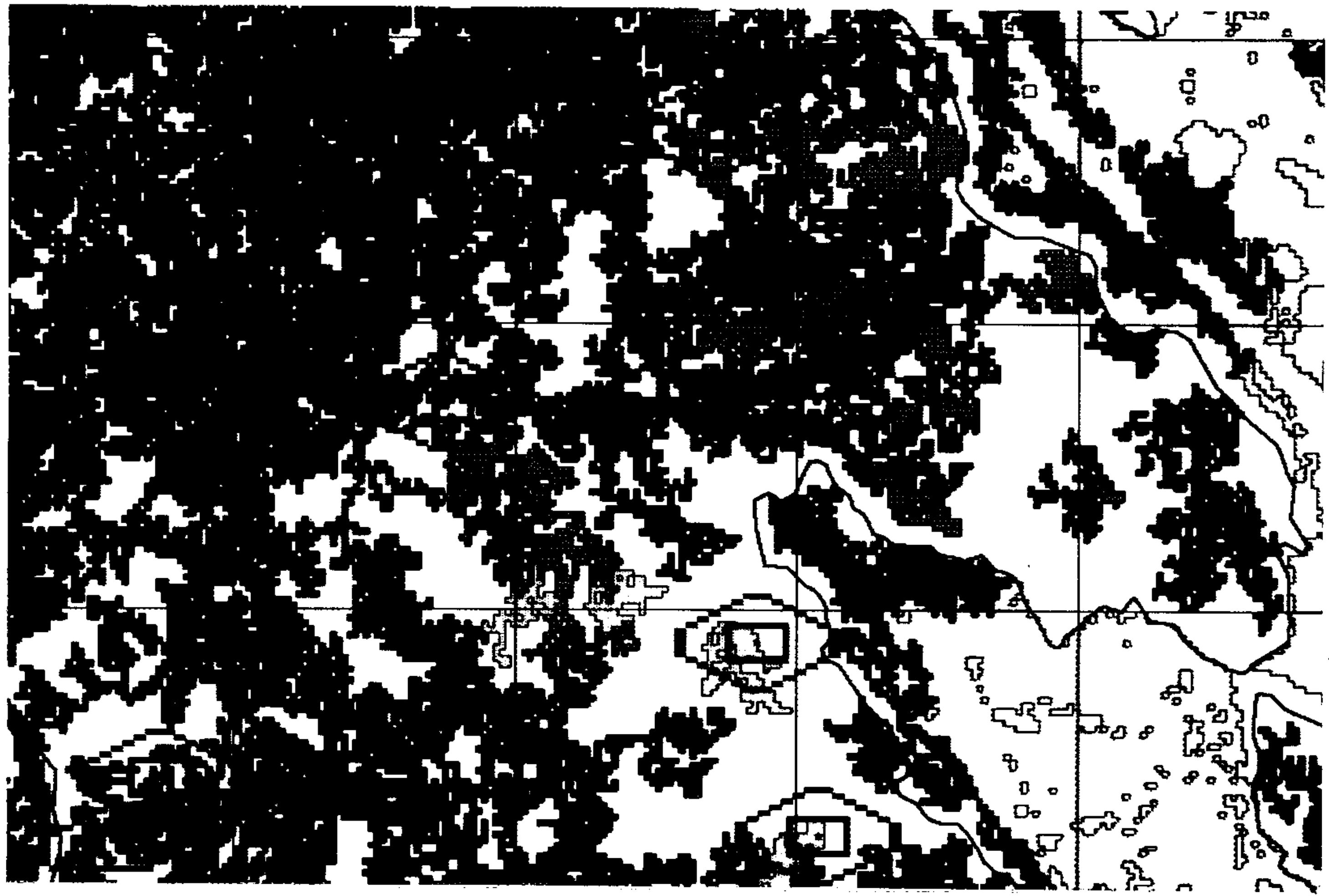

Figure 2. Example of Core Plot Locations at the Pohakuloa Training Area, HI.

**Table 1**

**Materials Needed To Establish LCTA Plots**

- Small spade or mattock
- Permanent stake
- 4-lb hammer
- Five 0.5-m lengths of 6-mm steel rod per plot
- Sighting compass
- 100-m measuring tape
- 1 to 4 heavy-duty clips
- 35-mm camera with color print film (100 ASA preferred)
- Plot map forms
- Photo logs
- Clipboard
- #2 lead pencil
- 1-liter sealable plastic bags for soil samples
- Aluminum tags
- Clinometer
- Handheld computer (recommended)
- Global positioning system (optional)

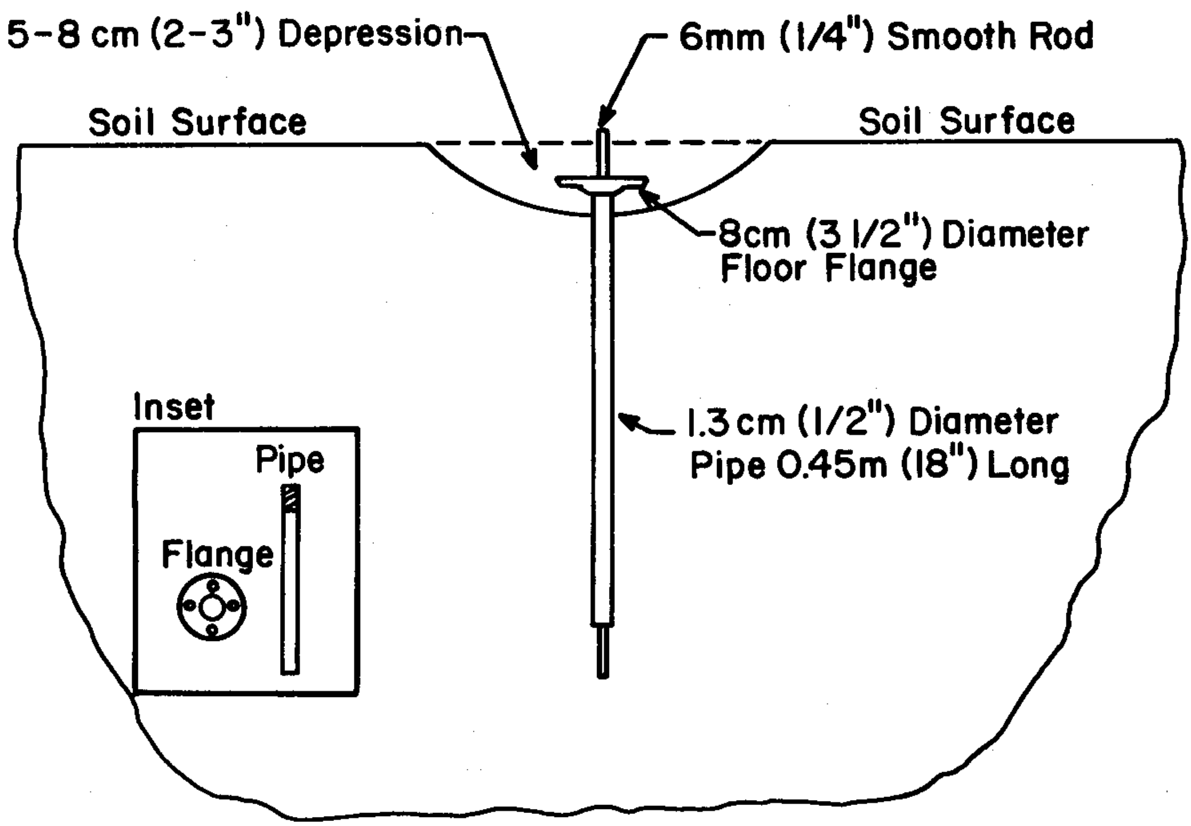


Figure 3. **Diagram of the Flanged Permanent Stake for Establishing the Location of All LCTA Plots.**

It is important to make LCTA plots as inconspicuous as possible. Fence posts, flags, and colored markers may attract attention and create a bias in the land uses in the area of the plots. Although the plots are inconspicuous, they can be relocated by field crews using properly prepared maps, metal detectors and, if necessary, a global positioning system (see "Plot Location Notebook," p 17).

After the beginning point has been established, the azimuth of the plot is selected randomly. Standing over the stake, a circle is envisioned around the point with a radius of 100 m. Portions of the circle falling outside the landcover/soil polygon are eliminated and the arc of the remaining portion of the circle is determined. A pencil point is blindly placed on a random number table (Table 2) and the nearest number is selected. If this number represents an azimuth that falls within the acceptable arc, it becomes the azimuth of the plot. If the number falls outside the arc, the process is repeated until an acceptable azimuth is selected. If a handheld computer is available, it can be programmed to select random azimuths automatically.

Once the azimuth of the plot has been selected, the measuring tape is attached to the beginning stake. One person unreels the tape on the selected azimuth, oriented by a second person standing over the stake with a sighting compass. It is important to unreel the tape as straight and as close to the ground as possible. Field crews may find it convenient for the person unreeling the tape to also carry four steel rods and the hammer. When the 100-m point is reached and the correct azimuth verified, a steel rod is hammered into the ground at the 100-m mark until approximately 1 cm protrudes above the surface. The tape is clipped to this rod. The remaining three steel rods are driven at the 75, 50, and 25-m points along the tape and the tape is clipped to them. Rods that cannot be driven completely into the ground due to an underlying rock layer are bent over to prevent flat tires and injuries.

In tall, dense scrub and woodlands, it may be necessary for the person unreeling the tape to carry a telescoping pole, extending it vertically to provide a target for the person with the sighting compass. In such cases, or if there is a strong wind, it may be necessary to lay out the line in 25-m segments. In all cases, care must be taken to ensure that the line is as straight as possible.

## Plot Location Notebook

To ensure the LCTA plots can be relocated, accurate site descriptions and maps must be prepared and photographs taken. Most of the descriptive information and maps are recorded on the Plot Map Form (Figure 4) during the initial inventory. This information, along with photographs taken at the initial inventory and in later years, is organized in a Plot Location Notebook. The notebook provides instructions so someone without prior knowledge of the site can relocate the beginning stake and resurvey the plot. The photographs document the condition of the plot over time. Depending on the number of plots, the plot location notebook may consist of one or more volumes. A separate notebook is assembled for special use plots.

### *Descriptive Information*

Each volume begins with a title page listing installation name, notebook category (core or special use plots), volume number, and plot numbers. A Plot Inventory and Monitoring Log follows the title page (Figure 5). This form specifies the initial inventory and subsequent monitoring dates for each plot contained within that volume. Next is the installation Plot Locator (Figure 6) listing each plot sequentially along with installation training area number, UTM coordinates, and USGS 7.5-minute quadrangle map name.

**Table 2**

**Random Numbers (1-360) for Selecting Line Transect Azimuths for LCTA Plots**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 297 | 287 | 100 | 154 | 293 | 191 | 312 | 306 | 9 | 170 | 277 | 267 | 218 | 214 | 220 |
| 97 | 123 | 109 | 133 | 197 | 328 | 248 | 300 | 88 | 79 | 238 | 330 | 250 | 120 | 241 |
| 172 | 269 | 293 | 296 | 175 | 113 | 27 | 31 | 235 | 304 | 143 | 226 | 323 | 87 | 335 |
| 315 | 344 | 223 | 144 | 57 | 247 | 275 | 113 | 193 | 277 | 177 | 245 | 271 | 355 | 264 |
| 191 | 285 | 116 | 31 | 220 | 173 | 4 | 160 | 99 | 307 | 126 | 305 | 209 | 152 | 220 |
| 112 | 119 | 124 | 358 | 242 | 61 | 289 | 19 | 158 | 158 | 81 | 355 | 96 | 102 | 6 |
| 307 | 218 | 261 | 197 | 222 | 198 | 78 | 277 | 15 | 336 | 207 | 32 | 265 | 245 | 263 |
| 256 | 128 | 216 | 353 | 247 | 230 | 88 | 211 | 343 | 353 | 338 | 110 | 97 | 65 | 268 |
| 135 | 12 | 196 | 93 | 317 | 306 | 122 | 102 | 311 | 206 | 213 | 28 | 28 | 193 | 33 |
| 225 | 235 | 323 | 69 | 170 | 103 | 134 | 62 | 39 | 3 | 340 | 267 | 193 | 320 | 158 |
| 89 | 331 | 272 | 251 | 6 | 205 | 61 | 26 | 274 | 257 | 275 | 201 | 179 | 216 | 8 |
| 242 | 329 | 113 | 16 | 298 | 164 | 115 | 224 | 212 | 146 | 108 | 355 | 275 | 331 | 156 |
| 32 | 35 | 58 | 83 | 264 | 328 | 118 | 126 | 180 | 162 | 205 | 126 | 337 | 137 | 282 |
| 55 | 351 | 147 | 347 | 191 | 81 | 16 | 236 | 289 | 302 | 283 | 256 | 110 | 105 | 252 |
| 45 | 19 | 102 | 151 | 119 | 44 | 284 | 318 | 315 | 351 | 119 | 45 | 28 | 23 | 107 |
| 16 | 121 | 147 | 352 | 4 | 59 | 28 | 129 | 103 | 193 | 128 | 86 | 218 | 103 | 120 |
| 99 | 11 | 317 | 198 | 41 | 113 | 241 | 65 | 38 | 18 | 18 | 266 | 254 | 249 | 35 |
| 17 | 319 | 174 | 327 | 71 | 138 | 26 | 139 | 231 | 223 | 152 | 135 | 279 | 116 | 67 |
| 167 | 177 | 196 | 357 | 99 | 141 | 340 | 106 | 80 | 162 | 112 | 79 | 262 | 188 | 241 |
| 226 | 357 | 50 | 328 | 251 | 88 | 175 | 344 | 153 | 239 | 163 | 259 | 352 | 301 | 128 |
| 261 | 88 | 8 | 86 | 16 | 183 | 4 | 133 | 159 | 52 | 132 | 286 | 70 | 185 | 233 |
| 66 | 117 | 14 | 125 | 268 | 112 | 321 | 302 | 231 | 108 | 259 | 314 | 189 | 98 | 186 |
| 312 | 238 | 88 | 264 | 54 | 297 | 104 | 96 | 296 | 62 | 313 | 201 | 311 | 79 | 163 |
| 289 | 355 | 287 | 86 | 204 | 167 | 273 | 304 | 284 | 360 | 92 | 116 | 323 | 189 | 167 |
| 285 | 270 | 49 | 311 | 323 | 186 | 91 | 324 | 289 | 173 | 324 | 226 | 24 | 182 | 4 |
| 92 | 295 | 190 | 270 | 43 | 73 | 267 | 190 | 221 | 137 | 95 | 352 | 25 | 170 | 121 |
| 257 | 21 | 267 | 251 | 144 | 110 | 214 | 43 | 124 | 60 | 92 | 328 | 348 | 327 | 111 |
| 52 | 17 | 80 | 173 | 113 | 203 | 270 | 38 | 357 | 234 | 208 | 205 | 294 | 156 | 140 |
| 306 | 238 | 83 | 134 | 273 | 351 | 151 | 101 | 281 | 321 | 30 | 302 | 178 | 199 | 102 |
| 149 | 186 | 82 | 179 | 87 | 84 | 134 | 290 | 226 | 13 | 345 | 154 | 351 | 243 | 114 |
| 142 | 241 | 283 | 66 | 91 | 217 | 234 | 295 | 235 | 160 | 138 | 243 | 179 | 319 | 348 |
| 214 | 86 | 136 | 151 | 347 | 261 | 159 | 57 | 168 | 129 | 89 | 124 | 268 | 113 | 154 |
| 282 | 21 | 189 | 281 | 297 | 184 | 28 | 178 | 25 | 245 | 355 | 92 | 324 | 260 | 196 |
| 174 | 17 | 213 | 335 | 316 | 255 | 284 | 337 | 9 | 7 | 253 | 193 | 193 | 92 | 87 |
| 212 | 264 | 296 | 24 | 145 | 56 | 256 | 33 | 144 | 116 | 336 | 98 | 335 | 116 | 173 |
| 71 | 167 | 348 | 208 | 280 | 318 | 172 | 270 | 8 | 36 | 20 | 327 | 351 | 344 | 100 |
| 202 | 48 | 289 | 231 | 318 | 156 | 123 | 277 | 127 | 129 | 171 | 168 | 261 | 176 | 157 |
| 260 | 71 | 238 | 261 | 19 | 357 | 28 | 184 | 5 | 141 | 34 | 47 | 7 | 83 | 42 |
| 225 | 287 | 305 | 336 | 280 | 61 | 192 | 121 | 252 | 13 | 13 | 121 | 291 | 333 | 26 |
| 152 | 286 | 50 | 356 | 253 | 293 | 273 | 98 | 342 | 163 | 278 | 88 | 126 | 124 | 348 |
| 315 | 238 | 109 | 124 | 310 | 262 | 149 | 52 | 92 | 236 | 327 | 69 | 107 | 114 | 231 |
| 61 | 140 | 193 | 209 | 21 | 103 | 100 | 58 | 289 | 31 | 84 | 288 | 165 | 31 | 136 |
| 317 | 30 | 306 | 14 | 125 | 7 | 344 | 132 | 302 | 245 | 181 | 265 | 312 | 326 | 190 |
| 2 | 218 | 85 | 109 | 148 | 25 | 40 | 140 | 257 | 294 | 71 | 261 | 35 | 232 | 290 |
| 295 | 278 | 59 | 81 | 144 | 132 | 252 | 313 | 119 | 314 | 149 | 159 | 263 | 185 | 68 |
| 191 | 352 | 329 | 79 | 355 | 74 | 121 | 212 | 115 | 90 | 205 | 165 | 9 | 145 | 8 |
| 95 | 66 | 286 | 22 | 4 | 347 | 13 | 341 | 25 | 163 | 232 | 145 | 88 | 92 | 53 |
| 142 | 192 | 223 | 62 | 312 | 253 | 2 | 344 | 65 | 148 | 109 | 20 | 80 | 2 | 162 |
| 237 | 17 | 167 | 176 | 197 | 335 | 180 | 215 | 54 | 190 | 262 | 179 | 323 | 156 | 340 |
| 231 | 127 | 249 | 248 | 312 | 59 | 37 | 327 | 173 | 150 | 288 | 79 | 345 | 117 | 188 |
| 273 | 20 | 62 | 247 | 194 | 62 | 276 | 55 | 164 | 82 | 223 | 345 | 262 | 122 | 99 |
| 116 | 42 | 13 | 359 | 28 | 153 | 208 | 3 | 101 | 200 | 316 | 147 | 99 | 186 | 75 |

## PLOT MAP FORM

Installation ______________________
Survey Date ______________________
Surveyor ______________________
Recorder ______________________
Plot Number ______________________
DMC ______________________
USGS Quad ______________________
Training Area ______________________
Soil Series ______________________
Vegetation Type ______________________

### Check List

| | | | |
|---|---|---|---|
| Permanent Stakes | ______ | Soil Samples | ______ |
| Location Maps | ______ | Line Transect | ______ |
| Photographs | ______ | Plants Collected | ______ |
| Slope | ______ | Belt Transect | ______ |
| Aspect | ______ | Land Use Form | ______ |

### Slope

| Location On Line Transect | Steepness (%) | Length(m) |
|---|---|---|
| 0 m | ______ | ______ |
| 50 m | ______ | ______ |
| 100 m | ______ | ______ |

### Aspect

Level (<5%) N NE E SE S SW W NW

### Mean Soil Depth (dm)

0 ____ 0-1 ____ 1-2 ____ 2-3 ____ 3-4 ____ >4 ____

### GENERAL LOCATION MAP

### SPECIFIC LOCATION MAP

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**Figure 4. Plot Map Form.**

PLOT INVENTORY AND MONITORING LOG

INSTALLATION______________________________

NOTEBOOK______________________ VOLUME______________________

| PLOT # | INVENTORY DATE(d/m/y) | MONITOR DATE (d/m/y) METHOD (S=short-term or L=long-term) | | |
|---|---|---|---|---|
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Figure 5. Plot Inventory and Monitoring Log.

PLOT LOCATOR

INSTALLATION NAME ____________________

| PLOT # | TRAINING AREA | UTM's<br>Easting Northing | QUADRANGLE NAME |
|---|---|---|---|
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Figure 6. Plot Locator.

*Maps*

The first map in the plot location notebook is a Composite Map Key (Figure 7) showing the location and the name of each USGS 7.5-minute quadrangle map covering the installation. Next is a reduced copy of each quadrangle map (Figure 8) showing the location of all plots located within that quadrangle. This is followed by a Plot Map Form (Figure 9) for each LCTA plot that includes a General Location Map and a Specific Location Map.

The General Location Map is completed in the field by sketching roads and landmarks that will aid in relocating the plot. A photocopy of the relevant portion of the installation map or the USGS map may be attached to the Plot Map Form in place of the sketch (Figure 10) with the plot location and map scale indicated. Either method is acceptable if care is taken to provide sufficient detail for relocation. Additional maps may be included in the Plot Location Notebook as needed.

The Specific Location Map also is completed in the field. It is an enlarged portion of the General Location Map, providing transect azimuth, azimuths and measured distances to at least two nearby landmarks, and other information needed to relocate the plot (Figures 9 and 10). Separate Plot Map Forms with labeled dividers make it easier to locate information on specific LCTA plots.

*Photographs*

Each Plot Map Form is accompanied by a transparent plastic page containing photographs taken at the time of plot establishment. All photographs are 3.5 x 5-in. color prints. A minimum of three photographs is required. The first documents the approach to the plot from the nearest road; the second the approach to the plot by foot; and the third is a panoramic view of the transect from the beginning stake. Other photographs may be taken as necessary. It is important that the exact location of the stake be visible in all photographs except the panoramic view of the transect. This can be accomplished by placing pin-flags around the stake or by having someone stand over the stake.

Each photograph is recorded in a Photo Log when it is taken (Figure 11). After developing the film, each photograph is labeled on the back with information from the Photo Log (i.e., the installation name or abbreviation, year, roll number, frame number, plot number, azimuth, and view description). A rubber stamp is available for labeling the back of each print (Figure 12).

Photographs taken when the plots are monitored must always include a panoramic view of the transect taken from the beginning stake. This provides a visual record to supplement the transect data in assessing change. Other photographs may be necessary to aid in future relocation if significant changes have occurred in the surrounding landscape.

Negatives of all photographs are stored in transparent plastic pages in a separate volume with a title page identifying the contents. Following the title page is a Photo Negative Log (Figure 13) containing the roll number and year the photographs were taken for each set of negatives in the volume. The negatives from each roll of film are stored on separate pages. The Photo Log prepared in the field, which contains a short description of each photograph, is placed with the corresponding negative page. Additional LCTA negatives may also be stored in this notebook, thus providing a library of supplemental photo records for each installation.

**USGS COMPOSITE MAP KEY**

INSTALLATION Fort Riley, Kansas

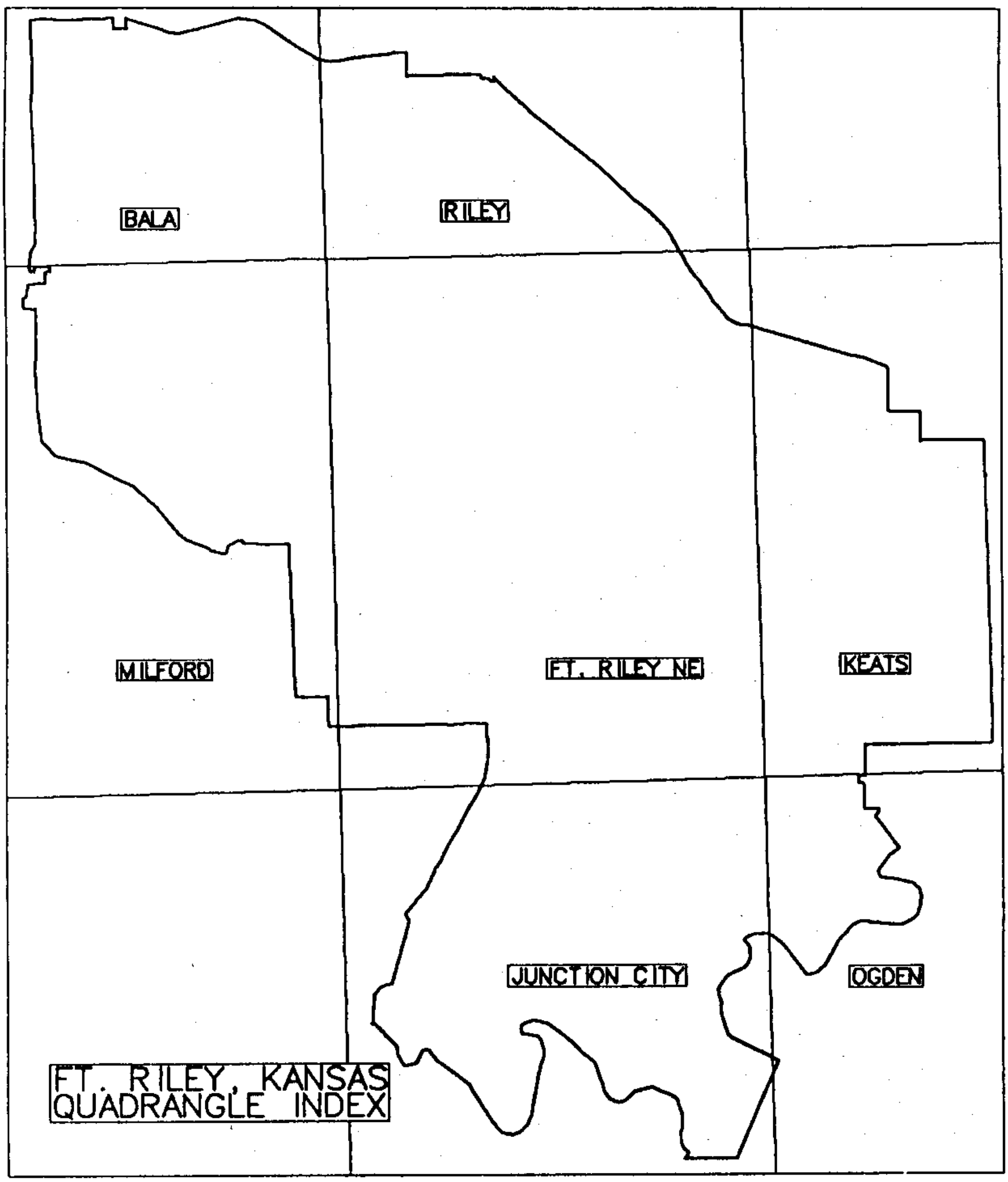


Figure 7. USGS Composite Map Key for Fort Riley, KS.

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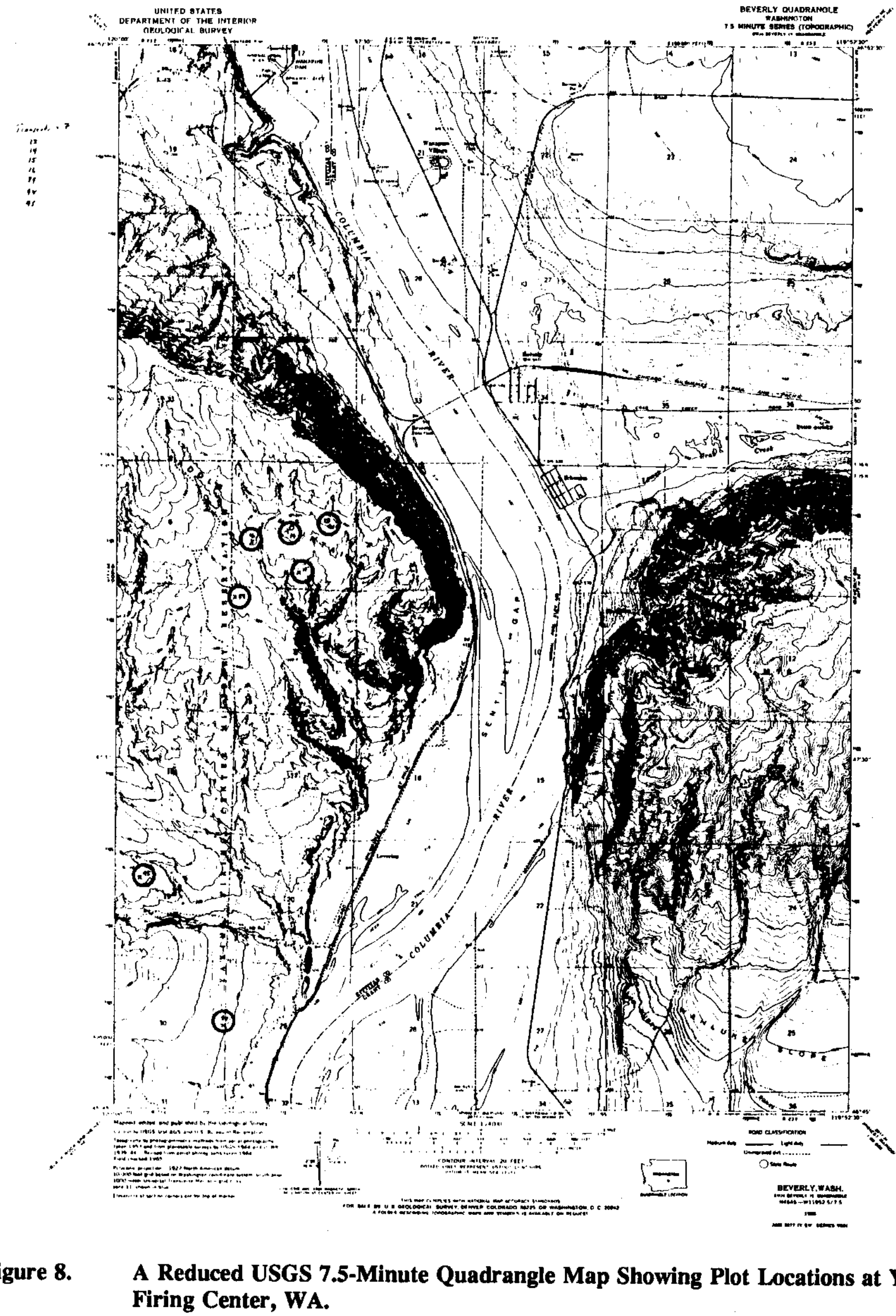



**Figure 8.** **A Reduced USGS 7.5-Minute Quadrangle Map Showing Plot Locations at Yakima Firing Center, WA.**

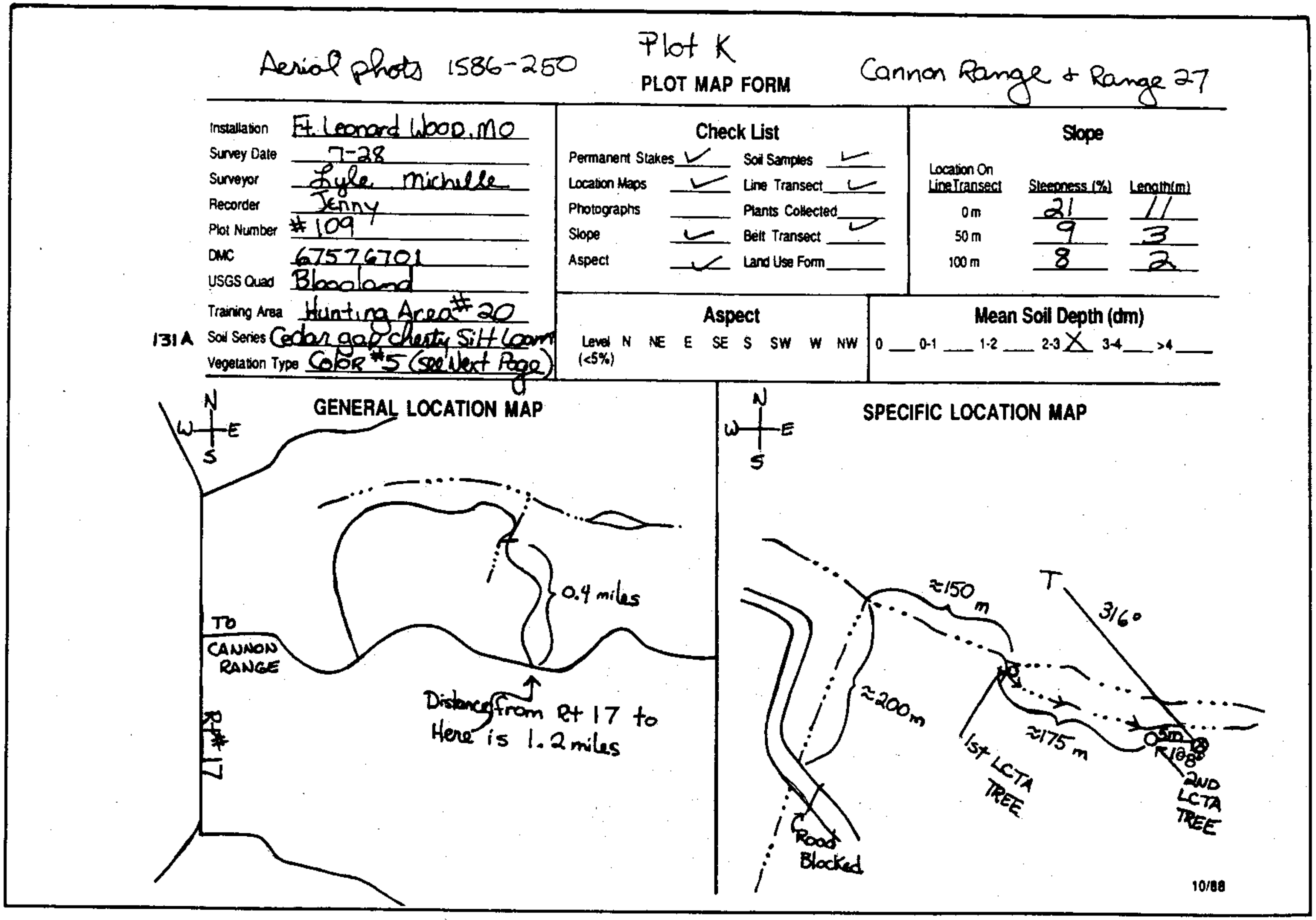
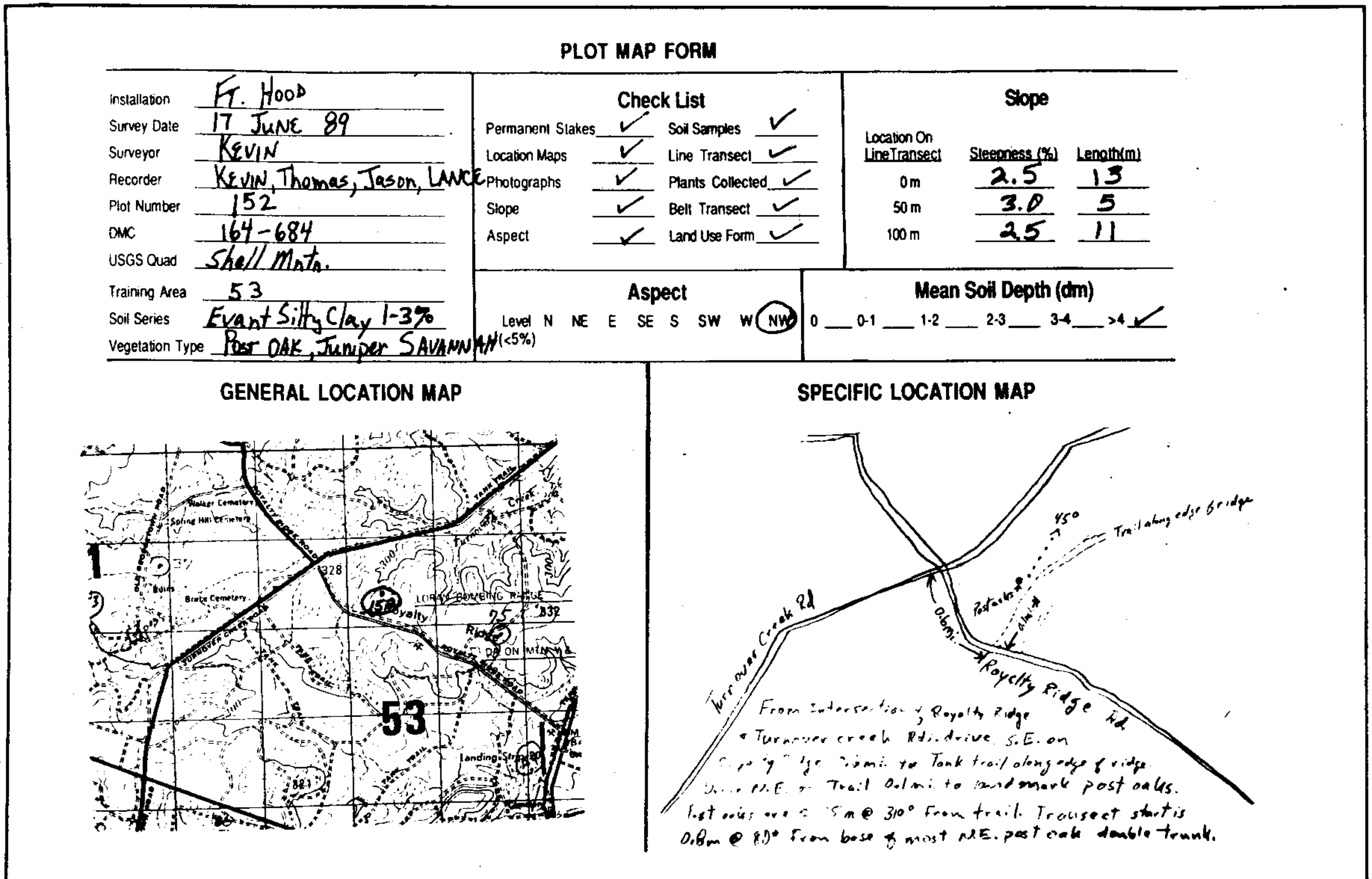



**Figure 9.** A Plot Map Form of Fort Leonard Wood, MO With Sketches for the General Location Map and Specific Location Map.



PLOT MAP FORM

| | |
|---|---|
| Installation | Ft. Hood |
| Survey Date | 17 June 89 |
| Surveyor | Kevin |
| Recorder | Kevin, Thomas, Jason, Lance |
| Plot Number | 152 |
| DMC | 164-684 |
| USGS Quad | Shell Mtn. |
| Training Area | 53 |
| Soil Series | Evant Silty Clay 1-3% |
| Vegetation Type | Post Oak, Juniper Savannah |

**Check List**

| | | | |
|---|---|---|---|
| Permanent Stakes | ✓ | Soil Samples | ✓ |
| Location Maps | ✓ | Line Transect | ✓ |
| Photographs | ✓ | Plants Collected | ✓ |
| Slope | ✓ | Belt Transect | ✓ |
| Aspect | ✓ | Land Use Form | ✓ |

**Slope**

| Location On Line Transect | Steepness (%) | Length (m) |
|---|---|---|
| 0 m | 2.5 | 13 |
| 50 m | 3.0 | 5 |
| 100 m | 2.5 | 11 |

**Aspect**

Level (<5%) N NE E SE S SW W NW

**Mean Soil Depth (dm)**

0 ___ 0-1 ___ 1-2 ___ 2-3 ___ 3-4 ___ >4 ✓

GENERAL LOCATION MAP



SPECIFIC LOCATION MAP



Figure 10. A Plot Map Form of Fort Hood, TX With an Enlarged Photocopy of a Part of the Installation Map Substituted for a Hand-Sketched General Location Map.

## Photo Log

Film Type ______________

ASA ______________

Roll No. ______________

| Ex. | Date | Plot No. | Azimuth | Location/Description |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
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| 20 | | | | |
| 21 | | | | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |

**Figure 11. Photo Log.**

**L C T A**

CODE ________ - ______ - ________ - ________
Installation   Yr   Roll   Frame

PLOT # ________ AZIMUTH ____________

APPROACH TO PLOT BY: ☐ ROAD ☐ FOOT

☐ PANORAMA VIEW OF PLOT

☐ OTHER ____________________

**Figure 12. Rubber Stamp for Labeling the Back of LCTA Photographs.**

## Soil and Topographic Information

### *Soil Depth Estimation*

Soil depth can have a significant effect on plant productivity and botanical composition. Shallow soils are generally less productive, more susceptible to damage and more difficult to reclaim than deeper soils. An estimate of soil depth is made for each LCTA plot by noting how deep it was possible to drive each of the steel rods into the soil. The average depth is recorded on the Plot Map Form (Figure 4). Care should be taken not to underestimate soil depth in rocky soils.

### *Soil Samples*

A composite soil sample is taken at each plot. Five small samples are taken approximately 1 m from the line transect at the zero, 25, 50, 75, and 100-m points. All litter is removed from the surface. With a narrow spade or mattock, a small pit approximately 15 cm deep is dug. A vertical slice comprising approximately 0.2 l of soil is taken from the side of each pit and roots and plant crowns are removed. The samples are combined in a sealable plastic bag along with a double-faced aluminum tag inscribed with the installation name or abbreviation and plot number. Sealed bags are boxed and shipped to the USDA National Soil Survey Laboratory in Lincoln, Nebraska for analysis of selected physical and chemical soil characteristics that affect site erodibility, productivity, and botanical composition. A record of all samples shipped must be maintained.

### *Aspect*

Aspect, which can influence soil moisture, botanical composition, and vegetation cover, is determined for plots while standing at the 50 m point and estimating the general direction that water would flow across the site. Using a compass, aspect is estimated to the nearest octant, and this direction is circled on the Plot Map Form (Figure 4). If the average slope is less than 5 percent, aspect is considered unimportant and "level" is circled on the form.

PHOTO NEGATIVE LOG

INSTALLATION________________________________ VOLUME_______________

| ROLL NUMBER | DATE | ROLL NUMBER | DATE | ROLL NUMBER | DATE |
|---|---|---|---|---|---|
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**Figure 13. Photo Negative Log.**

*Aspect*

Aspect, which can influence soil moisture, botanical composition, and vegetation cover, is determined for plots while standing at the 50 m point and estimating the general direction that water would flow across the site. Using a compass, aspect is estimated to the nearest octant, and this direction is circled on the Plot Map Form (Figure 4). If the average slope is less than 5 percent, aspect is considered unimportant and "level" is circled on the form.

*Slope Length and Gradient*

Slope length and gradient are measured at the zero, 50, and 100-m points and recorded on the Plot Map Form (Figure 4). Slope length is the straight-line distance runoff travels across each sample point. It is measured from the point of origin of runoff to a point where a barrier or significant reduction in slope causes overland flow to be diverted into a defined channel or causes suspended sediment to be deposited. The points of origin and diversion or deposition may result from a variety of obstructions or geographic features: (1) ridgetops and valley bottoms, (2) rivers, streams and gullies, (3) roads and trails, (4) deep ruts, (5) ditches, foxholes, and other excavations, (6) dense fence rows, shrub mottes or forested areas that significantly impede runoff (Figure 14).

Slope length is estimated by pacing the distance between point of origin and point of deposition. Slope gradient is measured with a clinometer to the nearest half percent. (Do not record in degrees.)

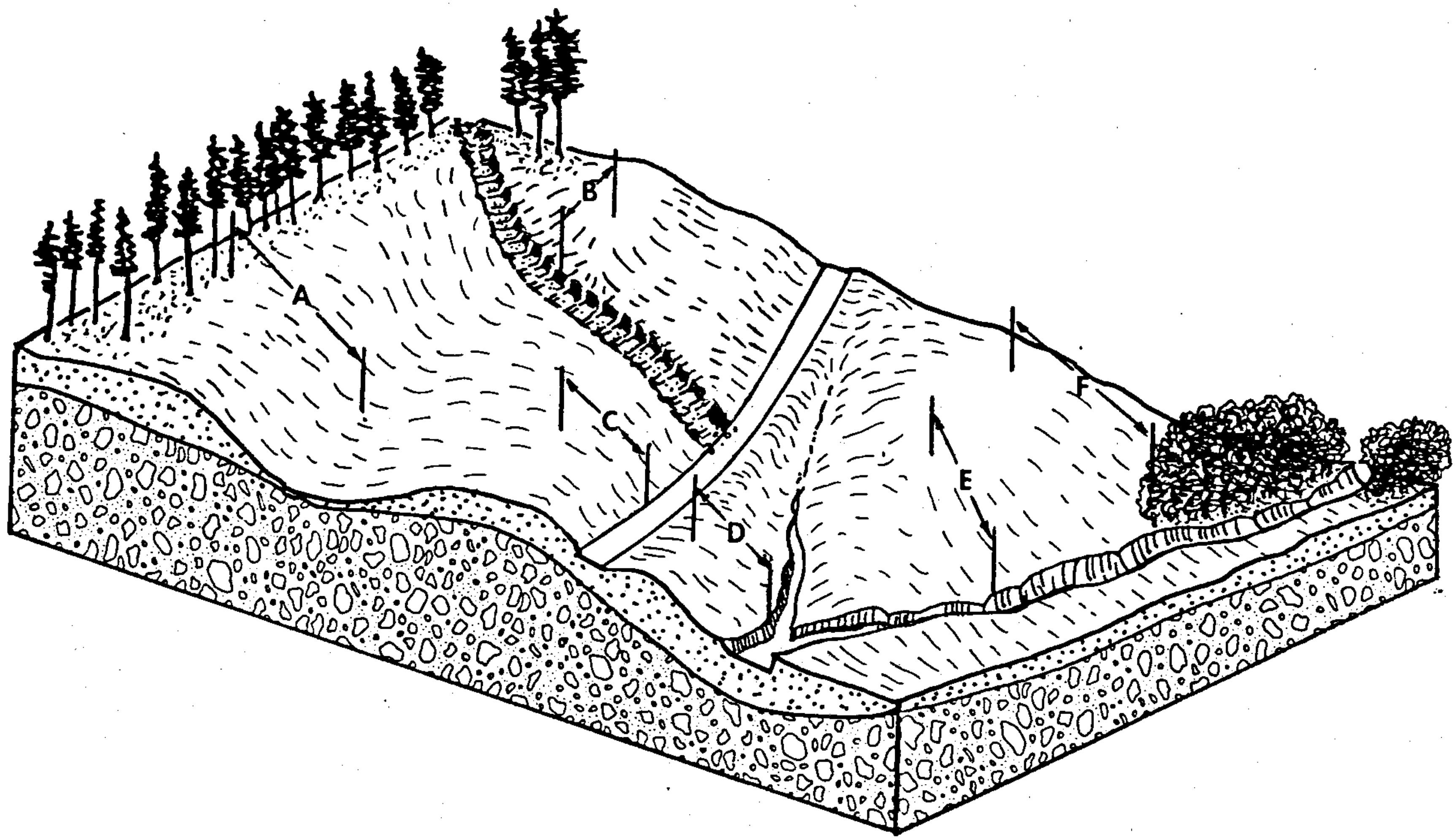


Figure 14. Examples of Slope Length Measurements.

# 3 PLANT COLLECTION

A primary goal of the LCTA program is to assemble a complete collection of all vascular plants that occur on an installation, and to produce a comprehensive, annotated list of all taxa present, including threatened and endangered species. Three specimens of each taxon are collected. One specimen is accessioned to a public herbarium to serve as a voucher. The remaining two specimens are laminated in plastic with a label (Figure 15) and included in a reference collection to be housed at the installation. The laminated specimens can then be taken into the field to aid in species identification by LCTA crew and natural resources personnel. Though the majority of taxa are collected in 1 to 3 years by a plant taxonomist contracted specifically for this task, species not yet included in the collection may be added any time by the field crew leader.

Every reasonable effort is made to collect specimens in flower and/or with fruit, in addition to stems, leaves, and, where they will aid in identification (e.g., grasses and forbs), roots. Specimens, which should not be collected on the line transect, are placed between sheets of newsprint labeled with the collection number, then between blotters and ventilators and into a standard plant press and dried thoroughly. For each specimen collected, a log sheet (Figure 16) is completed. Positive identification is made by comparison with herbarium specimens and published floras for the region, and verified by a qualified taxonomist.

Nomenclature and classification conform to the National List of Scientific Plant Names (USDA Soil Conservation Service, Publication SCS-TP-159, 1982).

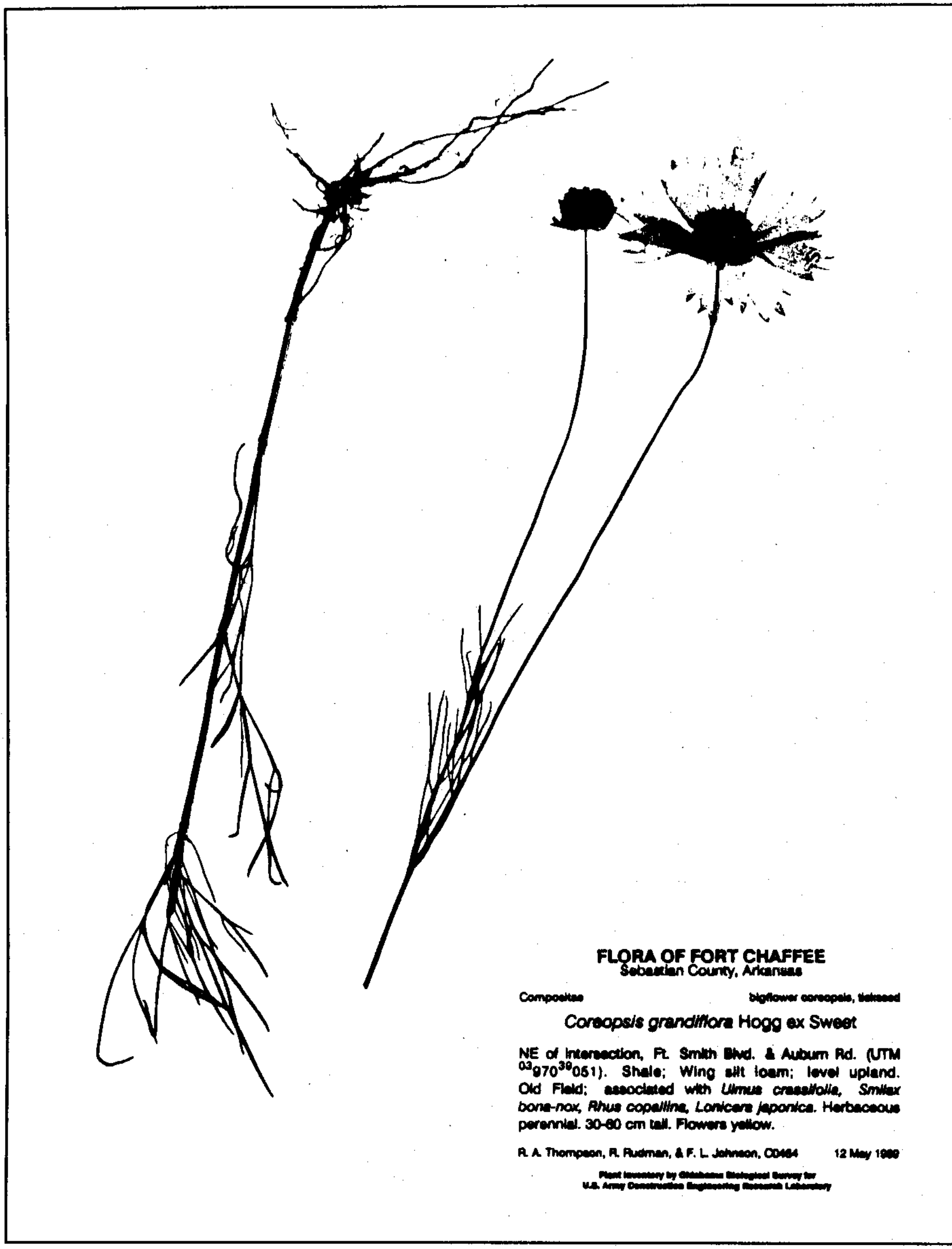


**Figure 15. A Pressed Herbarium Specimen With Label.**

## Plant Collection Log

STATE: ____________ INSTALLATION: ______________________ COUNTY: ______________

SPECIFIC LOCALITY: ____________________________________________

DMC/UTM ____________________________________________

ELEVATION: ______________ meters DATE: ______________________

DAY MONTH YEAR

COLLECTOR(S): ____________________________________________

SUBSTRATE & TOPOGRAPHY: ____________________________________________

ASSOCIATED TAXA/HABITAT: ____________________________________________

Record Family, Genus, Species, and Author

Space below name is reserved for description of plant (e.g. corolla color & markings; root structure; habit; height; abundance, etc.)

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

# ________ NAME: ____________________________________________

**Figure 16. Plant Collection Log.**

# 4 PLOT INVENTORY

Data collection is divided into three phases: initial inventory, short-term monitoring, and long-term monitoring. The initial inventory provides a detailed accounting of land use and site conditions. Subsequent monitoring is conducted annually to document trends in land use and condition of installation natural resources. Inventory procedures are detailed below. Short- and long-term monitoring are treated in the next chapter.

The plot inventory is conducted over a 2- to 3-month period during the peak of the growing season. Materials required to complete the inventory are listed in Table 3. All data can be entered on handheld computers in the field, bypassing the need for data forms and subsequent data transcription. The initial inventory consists of four major elements: land use assessment, line transect, belt transect, and wildlife sampling.

## Land Use

The Land Use Form (Figure 17) documents recent land uses and maintenance activities, as well as evidence of wind and water erosion that can be observed within the boundaries of the 100 × 6-m plot. These data are used to relate land use and maintenance activities to changes in vegetation and soil erosion rates.

Conditions observed on areas adjacent to but not within the plot proper are not checked on the Land Use Form. However, if noteworthy, such conditions may be recorded under the Additional Comments section of the form.

**Table 3**

**Materials Needed To Inventory LCTA Plots**

- Clipboard
- #2 pencil
- Land use form
- Line transect form
- Belt transect form
- Handheld computer (recommended)
- Global positioning system (optional)
- Metal detector
- 100-m measuring tape
- 1-m steel measuring rod (6-mm diameter) graduated in decimeter increments
- 7.5 m telescoping range pole

## Land Use Form

Installation__________________________ Plot Number __________ Date ___________

| Military Land Uses | | Non-Military Land Uses | |
|---|---|---|---|
| None | _____ | None | _____ |
| Wheeled | _____ | Grazing | |
| Tracked | _____ | sheep | _____ |
| Excavation | _____ | cattle | _____ |
| Foot | _____ | other | _____ |
| Bivouac | _____ | Row Crop | _____ |
| Demolition | _____ | Forestry | _____ |
| Other | _____ | Hay | _____ |
| (describe)__________ | | Other | _____ |
| ______________ | | (describe)__________ | |
| | | ______________ | |

### Maintenance Activities

| | | | |
|---|---|---|---|
| None | _____ | Seeding | _____ |
| Burning* | _____ | Tree Planting | _____ |
| prescribed | _____ | Chemical Application | _____ |
| accidental | _____ | (type)__________________ | |
| Tillage | _____ | Other___________________ | |
| Mowing | _____ | ______________________ | |

| Wind Erosion | | Water Erosion | |
|---|---|---|---|
| No evidence | _____ | No evidence | _____ |
| Drifting | _____ | Sheet/Rill | _____ |
| Scouring | _____ | Active Gully | _____ |
| Pedestal plants | _____ | Pedestal plants | _____ |
| | | Debris dams | _____ |

*Enter "C" if burn was within last 12 months; enter "P" if older.

Additional Comments:

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Figure 17. Land Use Form.

## Line Transect

The line transect documents ground cover, canopy cover, and surface disturbance. Data are recorded using a modified point intercept method.[27] The point intercept method has been shown to be more efficient than other sampling techniques[28] and is more universally applicable to a wide range of habitat types. Information derived from the line transect is used to evaluate soil erosion status, military concealment cover, wildlife habitat, and botanical composition, and for ground-truthing remotely sensed imagery.

One hundred points are sampled along the line transect beginning at the 0.5-m point and continuing at 1-m intervals along the measuring tape. The 1-m measuring rod is placed plumb to the ground at each point to determine ground cover, surface disturbance, and vertical distribution of vegetation up to 1 m (Figure 18). Canopy cover above 1 m is measured using the telescoping range pole.

If a plant species is encountered that cannot be identified, a specimen is collected away from the transect and assigned a number for future identification. The specimen number is entered on the Line Transect Form. The correct species code can be entered once proper identification is made. Plant collection procedures are discussed in Chapter 3.

### *Surface Disturbance*

If a point has been disturbed, the nature of the disturbance is determined and the appropriate category circled on the "Disturbance" line on the Line Transect Form (Figure 19). The categories of disturbance are described in Table 4. A point is considered disturbed if there is physical evidence of disruption of the soil surface or if the vegetation has been obviously crushed at that point. The fact that a site is in poor condition does not constitute evidence of disturbance. In the case of vehicle tracks, the ability to distinguish a general direction of travel is a prerequisite to establishing evidence of disturbance.

### *Ground Cover*

The second entry for each point on the Line Transect Form is for ground cover. Only material in contact with the ground at the tip of the measuring rod is recorded, i.e., the point at the center of the rod. Ground cover categories are listed in Table 5.

### *Canopy Cover*

The vertical distribution and composition of canopy cover is recorded on the Line Transect Form (Figure 19) by recording vegetation contacts within each decimeter interval on the 1-m measuring rod as it is held plumb to the ground. For vegetation above 1 m, the rod is replaced by a telescoping range pole.

---

[27] E.B. Levy and E.A. Madden, "The Point Method for Pasture Analysis," *New Zealand Journal of Agriculture*, No. 46 (1933), pp 267-279; D.W. Goodall, "Some Considerations in the Use of Point Quadrants for the Analysis of Vegetation," *Australian Journal of Scientific Research, Series B*, No 5 (1952), pp 1-41; —— "Point-Quadrant Methods for the Analysis of Vegetation," *Australian Journal of Botany*, No. 1 (1953), No. 1, pp 457-461; D. Mueller-Dombois and H. Ellenberg, *Aims and Methods of Vegetation Ecology* (John Wiley & Sons, Inc., New York, 1974).

[28] H.F. Heady, R.P. Gibbens, and R.W. Powell, "A Comparison of the Charting, Line Intercept, and Line Point Methods of Sampling Shrub Types of Vegetation," *Journal of Range Management*, No. 12 (1959), pp 180-188.

# GROUND COVER CATEGORIES

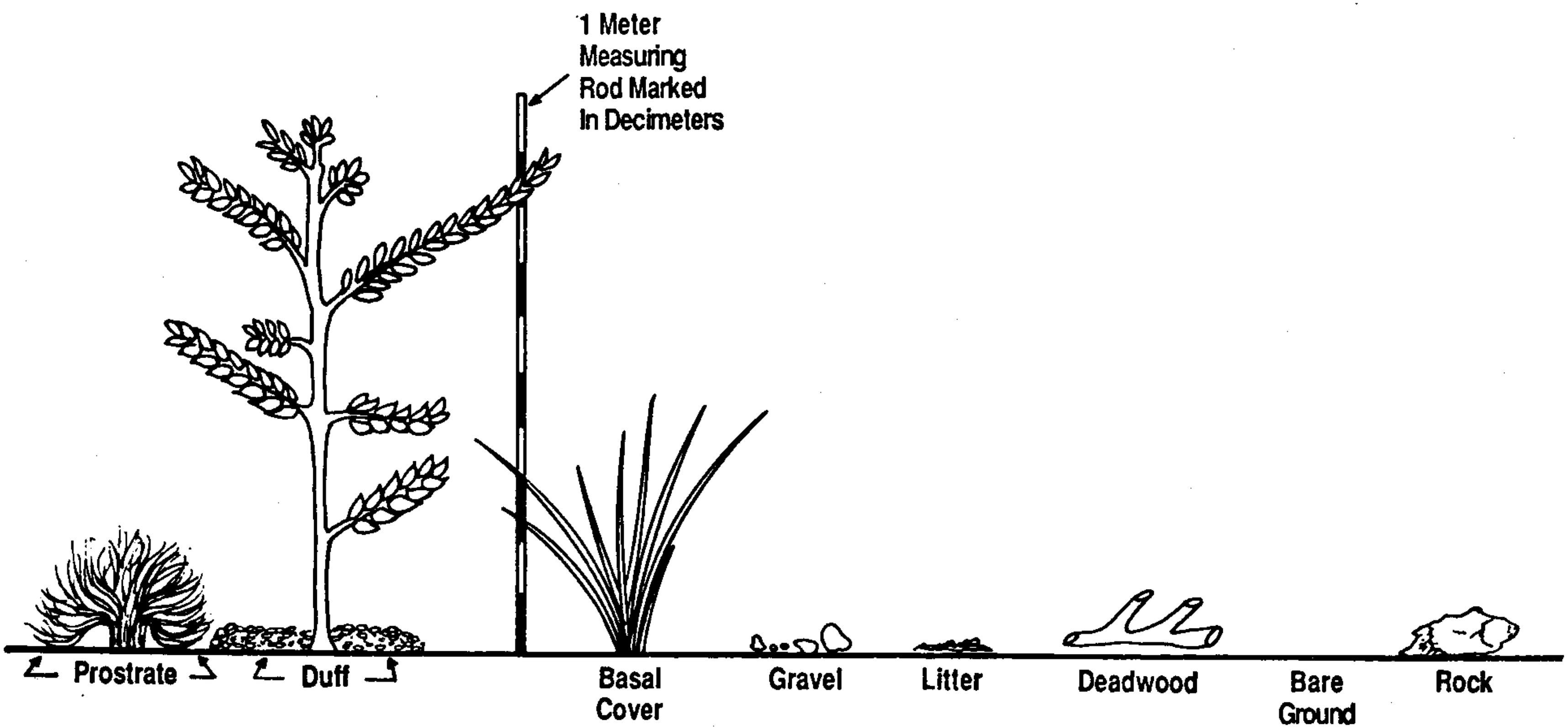


**Figure 18.** **The Eight Ground Cover Categories and the 1-m Measuring Rod Graduated in Decimeters Used To Quantify Ground and Aerial Cover.**

**LINE TRANSECT**

Installation________________ Plot No.________________

Date ________________

| Trans. Loc. | 0.5 | 1.5 | 2.5 | 3.5 | 4.5 | 5.5 | 6.5 | 7.5 | 8.5 | 9.5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Disturbance | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | N-RTPO | |
| **Cover** | | | | | | | | | | | |
| <.1 | | | | | | | | | | | <.1 |
| .1-.2 | | | | | | | | | | | .1-.2 |
| .2-.3 | | | | | | | | | | | .2-.3 |
| .3-.4 | | | | | | | | | | | .3-.4 |
| .4-.5 | | | | | | | | | | | .4-.5 |
| .5-.6 | | | | | | | | | | | .5-.6 |
| .6-.7 | | | | | | | | | | | .6-.7 |
| .7-.8 | | | | | | | | | | | .7-.8 |
| .8-.9 | | | | | | | | | | | .8-.9 |
| .9-1.0 | | | | | | | | | | | .9-1.0 |
| 1.0-1.1 | | | | | | | | | | | 1.0-1.1 |
| 1.1-1.2 | | | | | | | | | | | 1.1-1.2 |
| 1.2-1.3 | | | | | | | | | | | 1.2-1.3 |
| 1.3-1.4 | | | | | | | | | | | 1.3-1.4 |
| 1.4-1.5 | | | | | | | | | | | 1.4-1.5 |
| 1.5-1.6 | | | | | | | | | | | 1.5-1.6 |
| 1.6-1.7 | | | | | | | | | | | 1.6-1.7 |
| 1.7-1.8 | | | | | | | | | | | 1.7-1.8 |
| 1.8-1.9 | | | | | | | | | | | 1.8-1.9 |
| 1.9-2.0 | | | | | | | | | | | 1.9-2.0 |
| 2.0-2.5 | | | | | | | | | | | 2.0-2.5 |
| 2.5-3.0 | | | | | | | | | | | 2.5-3.0 |
| 3.0-3.5 | | | | | | | | | | | 3.0-3.5 |
| 3.5-4.0 | | | | | | | | | | | 3.5-4.0 |
| 4.0-4.5 | | | | | | | | | | | 4.0-4.5 |
| 4.5-5.0 | | | | | | | | | | | 4.5-5.0 |
| 5.0-5.5 | | | | | | | | | | | 5.0-5.5 |
| 5.5-6.0 | | | | | | | | | | | 5.5-6.0 |
| 6.0-6.5 | | | | | | | | | | | 6.0-6.5 |
| 6.5-7.0 | | | | | | | | | | | 6.5-7.0 |
| 7.0-7.5 | | | | | | | | | | | 7.0-7.5 |
| 7.5-8.0 | | | | | | | | | | | 7.5-8.0 |
| 8.0-8.5 | | | | | | | | | | | 8.0-8.5 |
| >8.5 | | | | | | | | | | | >8.5 |

**Figure 19. First Page of the Line Transect Form.**

Table 4

**Categories of Physical Disturbance Recorded on the Line Transect Form**

| Type | Code | Description |
|---|---|---|
| None | N | No evidence of physical disturbance to the soil surface or crushed vegetation. |
| Road | R | Permanent or semipermanent traffic route receiving periodic maintenance. |
| Trail | T | Semipermanent traffic route receiving no maintenance. |
| Pass | P | A random vehicle track that does not follow an established traffic pattern. |
| Other | O | Evidence of soil disturbance from nonvehicular sources such as excavation, demolition, bivouac activity, etc. |

Table 5

**Categories of Ground Cover Recorded on the Line Transect Form**

| Category | Code | Description |
|---|---|---|
| Basal cover | ____* | That part of a plant where the leaves and/or stem join the roots at the soil surface. Vascular plants are recorded by species code.* Record microphytes as MOSS, LICHEN or ALGAE. |
| Prostrate | ____* | Attached leaves, stems, stolons, etc. in contact with the soil surface away from the plant crown. |
| Dead wood | DW | Detached, fallen woody material ≥ 2.5 cm in at least two dimensions. |
| Litter | LG,LF<br>LS,LT | Detached herbaceous plant parts of any size, and woody material < 2.5 cm in at least two dimensions. The second letter code identifies the source of litter (i.e., G=grass, F=forb, S=shrub and T=tree). |
| Duff | DG,DF<br>DS,DT | Accumulations of litter ≥ 2.5 cm in depth. The second letter in the code identifies the source of litter (i.e., G=grass, F=forb, S=shrub and T=tree). |
| Rock | RO | Rock and other nonbiodegradable material ≥ 7.5 cm in any dimension. |
| Gravel | GR | Gravel and other nonbiodegradable material ≥ 2mm in any dimension and < 7.5 cm in all dimensions. |
| Bare ground | BG | Exposed soil. |

* See National List of Scientific Plant Names (USDA Soil Conservation Service, 1982).

Canopy cover is recorded in decimeter intervals to a height of 2 m. Above 2 m, it is recorded in 0.5-m intervals up to 8.5 m. Canopy cover contact is recorded only if vegetation appears as though it would be intercepted by the center of the rod or pole. Canopy cover above 8.5 m also is recorded as present if an imaginary extension of the range pole above 8.5 m would contact vegetation.

Canopy cover categories are listed in Table 6. Only one category is recorded per interval. If two or more species or categories contact the rod in the same interval, only the one at the highest point within the interval is recorded. If more than one species is present over 8.5 m, record only the topmost species.

### Belt Transect

The belt transect is intended to characterize species composition, density, and height distribution of woody and succulent vegetation. These data serve as the basis for: (1) documenting the availability of concealment resources for realistic military training; (2) characterizing tree and shrub growth rates; (3) establishing a continuous forest inventory (CFI); (4) assessing wildlife habitat; and (5) monitoring populations of endangered plant species.

The belt transect extends the length of the 100-m line transect. Although the belt has a standard width of 6 m (3 m to either side of the line transect), the width may be reduced for high density species according to the guidelines in Table 7. Any adjustments in the belt transect width are noted on the Belt Transect Form.

Using the measuring tape as a longitudinal scale and a range pole as a lateral scale, the location of all woody plants above a predetermined minimum height are mapped on the Belt Transect Form (Figure 20). In nonwooded areas (i.e., grasslands, savannahs, deserts, etc.) where most woody plants are less than 1 m high, the minimum height of species recorded is 0.1 m. In woodlands and forests where woody plants commonly exceed 1 m in height, the minimum height of species recorded is 1.0 m. The minimum height used for each plot is recorded on the Belt Transect Form.

All rooted shrubs and trees are recorded regardless of whether they are live or dead. All cacti, regardless of height, are recorded. No suffretescent (partly woody) species are recorded. For live individuals, a solid dot is used to mark their locations on the Belt Transect Form; an "x" is used to record the location of dead individuals. The species code[29] and height (to the nearest 0.1 m) of each individual is recorded beside the symbol used to mark its location. The height of individuals > 8.5 m tall is recorded as "8.5+".

Some woody plants tend to produce multiple stems from a common root system. Although they may appear to be separate plants, these multi-stemmed plants are recorded as a single individual. For plants that form dense stands by means of root sprouts, adventitious roots, or rhizomes, the entire clump (motte) is regarded as one individual. A dashed line is used to delineate the boundaries of such clumps on the data form. The height of the clump is determined by measuring the tallest stem within the clump. As a reference for future surveys, the natural resource manager on each installation should list all species treated as clonal, and define what constitutes a clump.

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[29] U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS), SCS Technical Publication No. 159, *National List of Scientific Plant Names* (1982).

**Table 6**

**Categories of Canopy Cover Recorded on the Line Transect Form**

| Category Code | Code | Description |
|---|---|---|
| Dead wood | DW | Any detached woody material ≥ 2.5 cm in any two dimensions. |
| Litter | LG,LF | Any detached herbaceous material of any size or any detached woody material <2.5 cm in any two dimensions. The second letter in the code identifies the source of litter (i.e., G = grass, F=forb, S=shrub and T=tree). |
| Foliar cover | ____* | Live or dead plants that are rooted in the soil. Vascular plants are recorded by species code.* |

* See National List of Scientific Plant Names (USDA Soil Conservation Service, 1982).

**Table 7**

**Criteria for Determining Belt Transect Width for Abundant Species on LCTA Plots**

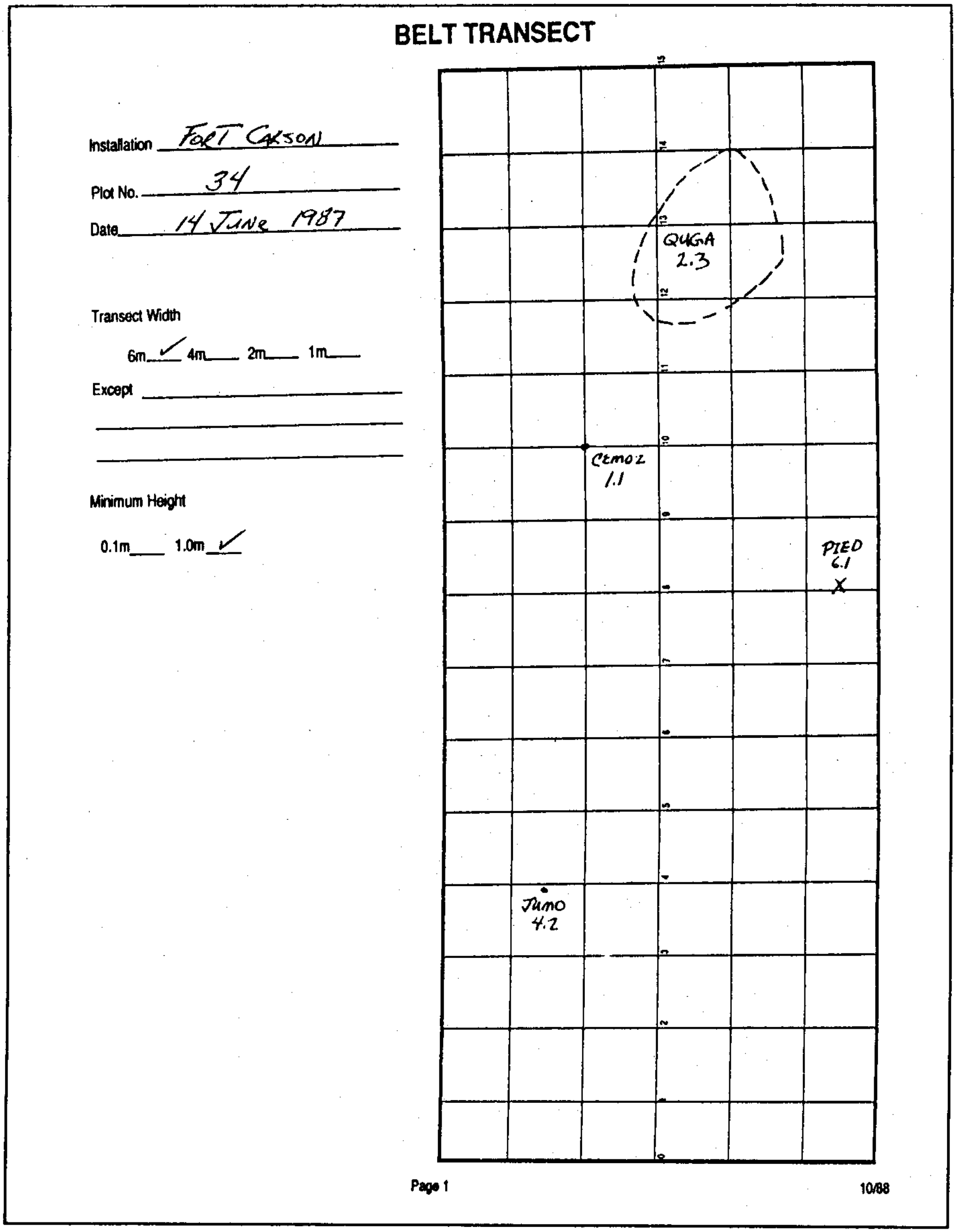
| Estimated Individuals of a Given Species per 6 m x 100 m Plot | Suggested Belt Width |
|---|---|
| < 100 | 6 m |
| 100 - 200 | 4 m |
| 200 - 400 | 2 m |
| > 400 | 1 m |

The examples given on the Belt Transect Form (Figure 20) are: (1) single-seeded juniper (JUMO=*Juniperus monosperma*), living, 4.2 m tall, 3.9 m down and 1.5 m to the left of the line transect; (2) pinyon pine (PIED=*Pinus edulis*), dead, 6.1 m tall, 8.1 m down and 2.5 m to the right; (3) mountain mahogany (CEMO=*Cercocarpus montanus*), living, 1.1 m tall, 10 m down and 1 m to the left; (4) Gambels oak clump (QUGA=*Quercus gambelii*), 2.3 m tall, 12.8 m down and 0.8 m to the right.

## Wildlife Inventory

A variety of wildlife data may be collected on or near LCTA plots. Only song bird and small mammal data are required as a standard. These taxa are useful as bio-indicators[30] and are easy to

[30] R.J. Douglass, "Assessment of the Use of Selected Rodents in Ecological Monitoring," *Environmental Management*, No. 13 (1989), pp 355-363; S.A. Temple and J.A. Wiens, "Bird Populations and Environmental Changes: Can Birds Be Bio-Indicators?", *American Birds*, No. 43 (1989), pp 260-270.



## BELT TRANSECT

Installation: FORT CARSON

Plot No.: 34

Date: 14 JUNE 1987

Transect Width

6m ✓ 4m___ 2m___ 1m___

Except ______

Minimum Height

0.1m___ 1.0m ✓



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**Figure 20. First Page of the Belt Transect Form.**

sample at the scale of the LCTA plot. Other data that may be collected include medium-sized mammal, carnivore, amphibian, reptile, invertebrate, ungulate pellet group, and browse utilization data.

Standard wildlife inventories are conducted on a subsample of approximately one-third of the core plots, up to a total of about 60. Core wildlife plots are selected in a stratified random fashion from among all the established core plots so as to represent the major soil and land cover types in proportion to their occurrence on the installation. This constitutes the minimum sampling required. More core plots are added as necessary to represent all soil and land cover types with at least one wildlife plot.

Additional sampling may be desirable to generate a more complete species list. This is done by increasing the number of core plots sampled, and by sampling special use plots and other unique habitats not included in the core plot allocation. These supplemental inventories follow the same methods prescribed for core plots to ensure data compatibility. Also, using the same methods on all core and special use plots permits a more extensive analysis of the relationships between wildlife, habitat, land use, and range condition and trend.

Materials needed to conduct wildlife inventories are listed in Table 8. Standardized common names[31] and associated vertebrate species codes (a list is available from USACERL) are used when recording field data. If any previously unknown threatened or endangered species are observed on an installation, the exact location of the sighting and other pertinent information should be recorded and relayed through the installation Natural Resources Office to state and federal wildlife agencies.

Standard wildlife data are collected during each of the first 3 years of LCTA implementation to establish a baseline for monitoring long-term trends. Resurveys are performed periodically thereafter as described in the next chapter.

*Birds (Standard)*

Birds are censused at each plot using a modified point-count transect technique.[32] Each plot is censused once in the morning and once in the evening by slowly walking the length of the LCTA plot in 6 minutes, recording all birds seen or heard within 100 m of the plot (Line Out in Figure 21). Upon reaching the end of the plot, the observer stops for 8 minutes and again records all birds seen or heard within 100 m (End Point). Finally, the observer walks back to the starting point in a period of 6 minutes again recording any birds detected within 100 m of the plot (Line In). All morning censuses are conducted between 0.5 hour before and 4 hours after sunrise on relatively calm, rainless days. The evening census is conducted during the 4 hours prior to sunset. Generally, four or five plots can be censused each morning and evening, thus requiring 12 to 15 days to inventory 60 plots. The inventory is conducted within a 2- to 4-week period corresponding to the seasonal peak in breeding bird activity, generally between 15 April and 30 June.

All birds detected are recorded on the LCTA Bird Survey Data Form (Figure 21) using standard common names and species codes (available from USACERL). Numbers of each species are recorded for each segment of the survey using the codes for mated status shown in Table 9. This information is used to infer the number of pairs present on the plot. A singing male, male/female pair, or adult

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[31] R.C. Banks, R.W. McDiarmid, and A.C. Gardner, *Checklist of Vertebrates of the United States, the U.S. Territories, and Canada* (U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1987).

[32] J. Blondel, C. Ferry, and B. Frochet, "Point Counts With Unlimited Distance," *Studies in Aviation Biology*, No. 6 (1981), pp 414-420.

**Table 8**

**Materials Needed To Conduct LCTA Wildlife Inventories**

Small mammals (for up to 10 plots per night) (required)
- State wildlife collecting permits
- 400 museum special snap traps
- 100 rat traps
- Snap trap carrying bag
- Rolled oats and peanut butter for snap traps
- Sealable plastic bags for specimens
- Aluminum tags

Birds (required)
- 7 to 10 power binoculars
- Watch

Medium-sized mammals (optional)
- State wildlife collecting permits
- 8 to 10 medium-sized cage traps (e.g., Havahart)
- Bait (sardines, chicken eggs, or scrap meat)
- Fatty acid scent (FAS) disks
- 1-meter circular form
- 1-1/2 mm soil sieve

Bats (optional)
- State wildlife collecting permits
- 5 or more mist-nets
- 10 8-10' net poles

Reptiles/amphibians (optional) (for 60 plots)
- State wildlife collecting permits
- 240 5-gallon buckets with lids
- 800 feet of aluminum flashing for drift fences
- 250 wooden or metal stakes
- 36 to 60 box or funnel traps (recommended)
- Shovel, pick, and post hole digger

accompanied by young indicates one pair present. Presence of additional pairs can be inferred only if additional singing males, male/female pairs, or same sex adults accompanied by young are observed. An individual nonsinging male, lone female, or individual of unknown sex or age indicates presence of the species but may not indicate a second pair. Flyovers of birds not using the plot, and other birds observed outside the plot limits are enumerated in the OTHER column. In the MAX PAIR column, the maximum number of pairs observed among the three segments of the survey is recorded. For flocks, record the total estimated number observed regardless of age and sex. For each segment, care must be taken not to record the same individuals more than once.

*Small Mammals (Standard)*

Small mammals are surveyed by setting two rows of 20 museum special traps and five rat traps parallel to the long axis of each LCTA plot (Figure 22). Trap stations are spaced approximately 7.5 m apart; trap lines are spaced 30 m apart. Snap traps are baited with a mixture of rolled oats and peanut butter and run for two nights for a total of 100 trap nights per plot. Traps are set during the late afternoon or evening of the first day, checked early the next morning, reset during the late afternoon or

## LCTA BIRD SURVEY PLOT SUMMARY

Installation____________ LCTA Plot Number________ Observer________________

Date____________ Starting time________ AM PM (circle one)

Cloud Cover (%)______ Wind_______ Temp ($C^{O}$)______

| COMMON NAME | SPECIES CODE | NUMBER OF BIRDS OBSERVED INSIDE PLOT | | | OTHERS[a] | MAX PAIRS |
|---|---|---|---|---|---|---|
| | | Line out (6 min) | End Point (8 min) | Line In (6 mi) | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |

a This category includes species observed outside the plot limits, and flyovers of birds not using the plot.

Figure 21. LCTA Bird Survey Data Form.

**Table 9**

**Categories of Mated Status Recorded on the LCTA Bird Survey Data Form**

| Code | Mated Status |
|---|---|
| * | Singing male |
| pr | Adult male/female pair |
| m | Nonsinging male |
| f | Female only |
| u | Unknown sex and age |
| y | Young of the year** |
| Flock | Flock of unknown sex and age |

**If adults are accompanied by young, enter a 'y' in addition to other codes.

evening of the second day, and checked and collected on the following morning. While in the field, captures for each site and day are placed in separate sealable plastic bags, labeled and then frozen or stored on ice until they can be examined for positive identification. All specimens are recorded on the LCTA Small Mammal Summary Data Form (Figure 23).

Usually, four to six plots can be trapped each night, thus requiring about 12 to 17 consecutive days to inventory 60 plots. Trapping must be completed in as short a time as possible during an expected regional peak in small mammal diversity and abundance. In most areas, late spring or early fall is favorable. In the southeastern United States, winter (January to February) is preferable to summer because of fewer ant problems and greater responsiveness of animals to bait. The season selected must be consistent from year to year. The use of snap traps for censusing small mammals is discussed in Davis.[33] The presence of threatened or endangered small mammal species on the installation may necessitate the use of live traps and a Federal permit.

*Medium-Sized Mammals (Optional)*

Wire mesh cage traps are placed at selected plots and sites to document the presence of medium-sized mammals such as skunks, raccoons, opossums, etc., and to control predation by such species on captured small mammals. This can be conducted in conjunction with the small mammal trapping, but traps should be placed away from areas where they may be vandalized. Cage traps are typically baited with sardines, chicken eggs, or scrap meat. All mammals captured in the cage traps are recorded on the LCTA Medium-Sized Mammal Data Form (Figure 24), and usually released.

An alternative to live-trapping is the use of scent stations, developed primarily to monitor carnivore populations in the western United States.[34] Each station consists of a 1-m diameter circle of finely sifted soil with a fatty acid scent (FAS) disk, or other scent, in the center. Tracks left in the sifted

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[33] Davis, D.E., *CRC Handbook of Census Methods for Terrestrial Vertebrates* (CRC Press, Inc., Boca Raton, FL, 1983).

[34] M.C. Conner, R.F. Labisky, and D.R. Progulske, Jr., "Scent-Station Indices as Measures of Population Abundance for Bobcats, Raccoons, Gray Foxes, and Opossums," *Wildlife Society Bulletin*, No. 11 (1983), pp 146-152; F.G. Lindzey and F.F. Knowlton, "Determining the Relative Abundance of Coyotes by Scent Station Lines," *Wildlife Society Bulletin*, No. 3 (1975), pp 119-124; R.D. Roughton and M.W. Sweeny, "Refinements in Scent-Station Methodology for Assessing Trends in Carnivore Populations," *Journal of Wildlife Management*, No. 46 (1982), pp 217-229.

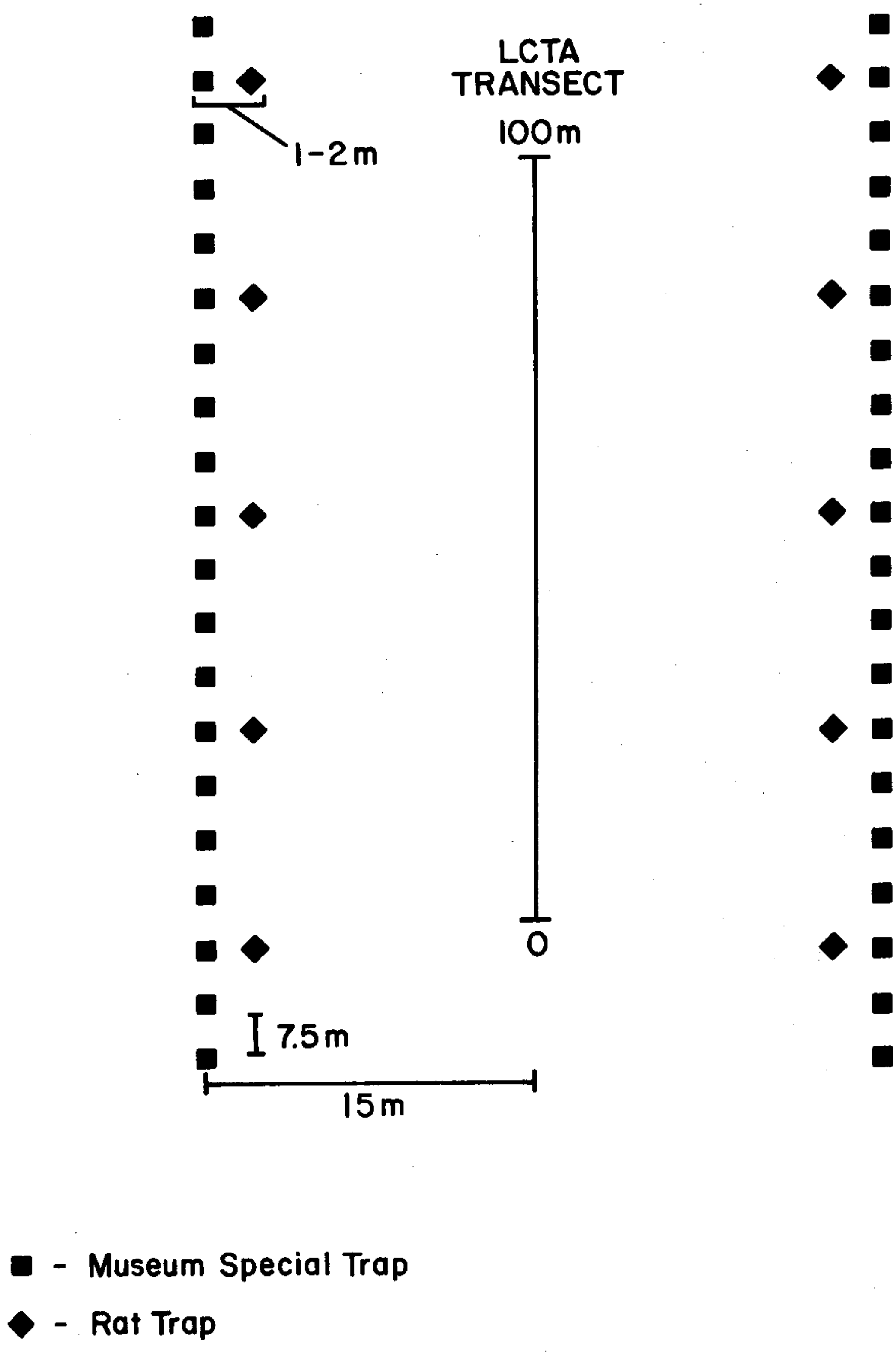


**Figure 22. Small Mammal Trapping Configuration.**

**LCTA SMALL MAMMAL SURVEY PLOT SUMMARY**

Installation________________ LCTA Plot Number__________

UTM Coordinates (E)________________ (N)________________

Collector(s)________________________________________

Collecting Dates____________________________________

Traps Used__________________ Total Trapnights__________

Bait(s) Used________________________________________

GENERAL WEATHER CONDITIONS OVER THE TRAPPING PERIOD:

Temp ($C^0$) High__________ Low__________________

Cloud Cover (%)________________________________

Precipitation__________________________________

**SPECIMENS COLLECTED**

| **SPECIES CODE** | MALE | FEMALE | UNKNOWN | **TOTAL** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Other mammalian species identified while at plot (tracks, scat, etc.):

Provide a detailed map showing the location of the site if traps were not associated with an LCTA plot (use back of sheet).

Figure 23. LCTA Small Mammal Summary Data Form.

**LCTA MEDIUM-SIZED MAMMAL PLOT SUMMARY**

Installation ________________ LCTA Plot Number ________

UTM Coordinates (E) ______________ (N) ______________

Collecting Dates ____________________________________

Collector(s) ________________________________________

Type and Number of Traps Set ________________________

Total Number of Trapnights at Site __________________

Bait(s) Used ________________________________________

**SPECIMENS CAPTURED**

| SPECIES CODE | MALES | FEMALES | UNKNOWN | TOTAL |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

OTHER MAMMALIAN SPECIES IDENTIFIED WHILE IN AREA (TRACKS, SCAT, ETC.):

PROVIDE A DETAILED MAP SHOWING THE LOCATION OF THE SITE IF TRAPS WERE NOT ASSOCIATED WITH AN LCTA PLOT (USE BACK OF SHEET IF NECESSARY).

Figure 24. LCTA Medium-Sized Mammal Data Form.

soil are identified to species, if possible. Scent station surveys are not performed concurrently with small mammal trapping to avoid depredation of small mammal captures. Each station is monitored one night and spaced to avoid attracting the same animal to more than one station.

*Bats (Optional)*

Bats typically are surveyed using mist nets placed over a perennial water source about 1 hour before dusk. Nets must be checked frequently, preferably every 15 minutes.[35] Net length, mesh size (usually 1.5 in.), and setup duration are at the discretion of the biologists conducting the survey. All captured bats are recorded by species on the LCTA Bat Survey Data Form (Figure 25).

*Reptiles and Amphibians (Optional)*

Reptiles and amphibians are censused using a pitfall trapping array with optional box traps[36] in association with the LCTA transects (Figure 26). The central bucket of each pitfall array is located approximately 75 m from the origin of the LCTA line transect, and at a random azimuth within a 180 degree arc opposite the azimuth of the transect. The array must be in the same soil type and landcover category as the LCTA transect. The 100-m point may be used as the point of origin if necessary to keep the array within the correct soil type and landcover category. The four 5-gallon plastic buckets are buried so the lip is flush with the soil surface. A cover is placed above the bucket, supported by rocks or wood blocks, to provide shade to any trapped animals. Aluminum drift fences 8 to 12 in. high, buried 2 to 3 in. in the ground and held in place by wooden or metal stakes are used to funnel animals into the buckets. The fence should be painted to blend with surroundings to make it less conspicuous and less prone to disturbance. The fence must overlap the lip of the bucket by about 1 in. to force the animals into the bucket and prevent them from moving around the end of the aluminum.

Captured animals are removed from the pitfalls once daily, if possible, with some specimens being retained as vouchers. All other should be marked in some manner and released unharmed near the point of capture. If possible, each array should remain open for 7 to 14 days during periods of high amphibian/reptile activity. Because peak activity periods for reptiles and amphibians differ depending on species, establishing and monitoring pitfall arrays on all wildlife plots (typically 60 plots) for the entire field season is frequently not practical. In such cases, it is recommended to survey a subset of the wildlife plots (e.g., 30 to 40 plots) for the full 7 to 14 days rather than to survey all plots for a shorter period. The subset of plots should include two or more plots in each major vegetation/soil type to estimate variability within the habitat.

Supplemental censusing techniques such as noosing, road riding, or use of funnel or box traps may be combined with the pitfall arrays to provide a more complete species list, since the pitfall trapping method is not effective for all species. Alternative trapping arrays, including linear configurations of one to four traps, are being investigated.

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[35] S.P. Cross, "Bats," in A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart, eds., *Inventory and Monitoring of Wildlife Habitat* (U.S. Department of the Interior, Bureau of Land Management Service Center, Denver, CO, 1986), pp 497-517.

[36] K.B. Jones, Technical Note 353, *Distribution, Ecology, and Habitat Management of the Reptiles and Amphibians of the Hualapai-Aquarius Planning Area, Mohave and Yavapai Counties, AZ* (U.S. Department of the Interior, Bureau of Land Management, Denver, CO, 1981).

**LCTA BAT SURVEY SITE SUMMARY**

Installation________________________________________

UTM Coordinates (E)__________________(N)__________________

Date/Time__________________________________________

Collector(s)________________________________________

Weather Conditions__________________________________

Dimensions of Mist Net______________________________

General Description of Site___________________________

_____________________________________________________

**SPECIMENS COLLECTED**

| **SPECIES CODE** | MALES | FEMALES | UNKNOWN | **TOTAL** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Draw a detailed map showing site location (can use back of sheet):

**Figure 25. LCTA Bat Survey Data Form.**

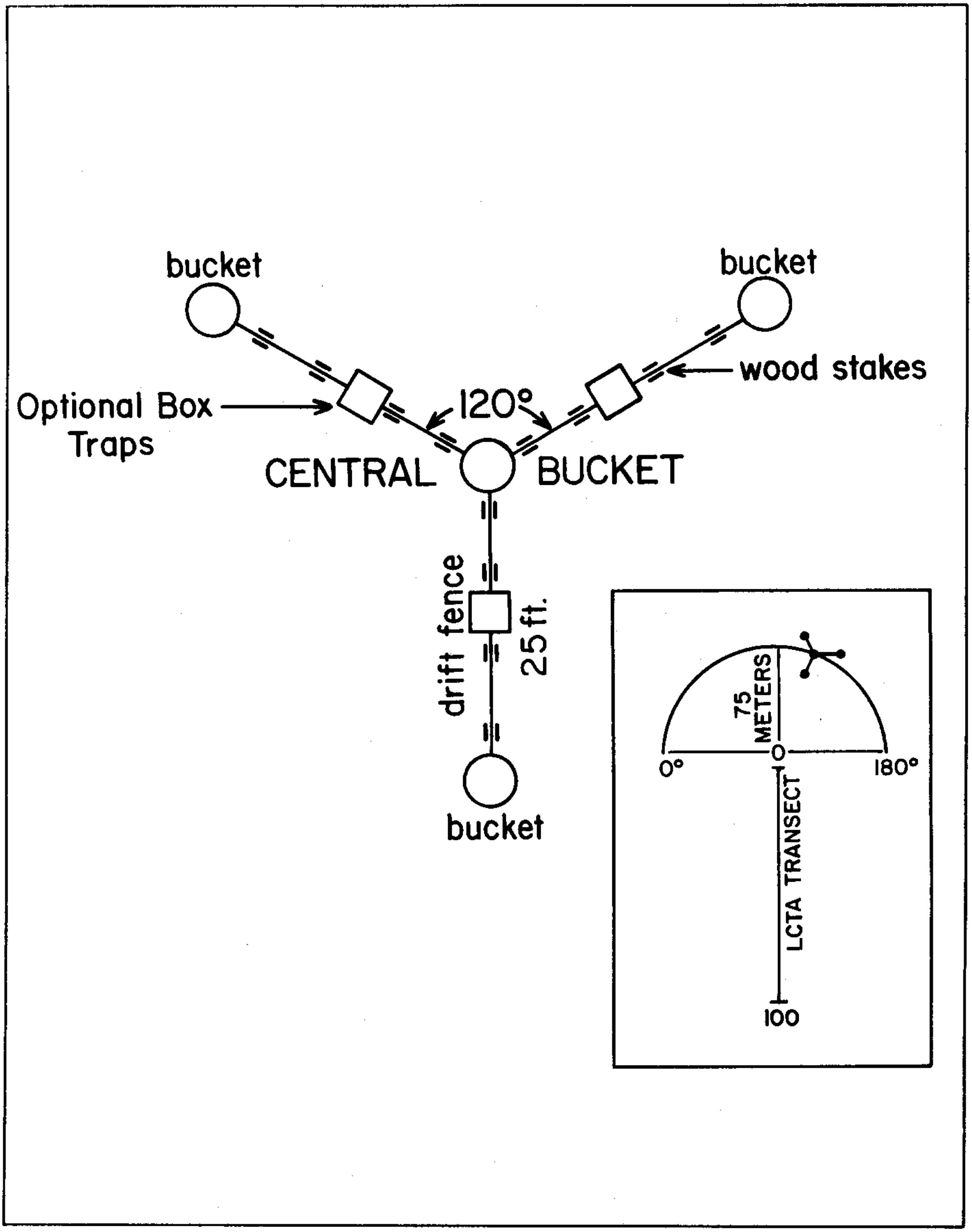


**Figure 26. Pitfall Trap Configuration To Capture Reptiles and Amphibians on LCTA Plots.**

**LCTA HERPETOFAUNA PLOT SUMMARY FORM**

Installation_______________LCTA Plot Number_______________

Azimuth from 0 or 100 meter point (circle one)___________

Survey Dates_______________________________________________

Surveyor(s)_______________________________________________

IF INCIDENTAL COLLECTING, STATE COLLECTING METHOD(S):

___________________________________________________________

___________________________________________________________

GENERAL WEATHER CONDITIONS OVER THE SURVEY PERIOD:

TEMP ($C^0$) HIGH____________ LOW______________

% CLOUD COVER________________________________

WIND CONDITIONS______________________________

**SPECIMENS COLLECTED**

| **SPECIES CODE** | MALES | FEMALES | UNKNOWN | **TOTAL** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Other Reptilian/Amphibian Species Identified While at Plot:

**Figure 27. LCTA Herpetofauna Survey Data Form.**

# 5 MONITORING

To detect changes in land use, disturbance, ground cover, canopy cover, species composition, woody plant density, etc., the permanent plots established in the initial inventory must be monitored on a regular basis (usually once per year). This "Short-Term Monitoring" is a scaled-down version of the initial inventory. Depending on the nature and intensity of land use, the plots are completely resurveyed every 3 to 5 years. This is called "Long-Term Monitoring" and entails data collection on the line and belt transects just as in the initial inventory. Short- and long-term monitoring must be conducted during the same time of year as the initial inventory.

## Short-Term Monitoring

The field procedures used in Short-Term Monitoring yield much the same information as those in Long-Term Monitoring, but in lesser detail, particularly with regard to species composition. The objective is to gather sufficient information to detect annual changes while minimizing demands on staff. Consequently, the procedures are streamlined and less time-consuming than in Long-Term Monitoring. A list of equipment needed for Short-Term Monitoring is provided in Table 10.

### *Plot Relocation*

Depending on the distance between plots and the nature of the vegetation, up to seven plots can be monitored in a day. Careful daily planning will minimize travel time between plots. A two-person crew is most efficient for Short-Term Monitoring.

**Table 10**

**Equipment Needed for Short-Term Monitoring of LCTA Plots**

- Metal detector
- Global positioning system (optional)
- Plot relocation notebook
- Mattock or shovel
- 100-m measuring tape
- Compass
- Heavy duty clips
- 35-mm camera with print film (ASA 100 preferred)
- 1-m measuring rod with 0.1 m graduations
- 7.5-m telescoping range pole
- Clipboard
- #2 lead pencil
- Land use form
- Short-term monitoring line transect form
- Short-term monitoring belt transect form
- Photo log
- Plant collection log
- Replacement stakes and rods
- 4-lb hammer
- Plant press
- Hand-held data recorder (optional)

Using the Plot Location Notebook, the field crew drives as close as possible to the plot. Referring to the General Location Map, the Specific Location Map and the plot photos, it should be possible to walk to within a few meters of the permanent stake marking the beginning of the transect. (Magnetic North may vary a few degrees over time, so adjustments must be made to compensate for differences from the azimuths noted on the location maps). In remote areas with few landmarks, a global positioning system may be needed to navigate to the site.

Once the search area has been narrowed down to a few square meters, a metal detector and a pick or shovel are used to locate the stake. When the stake has been located, the 100-m measuring tape is hooked to the metal rod and stretched out on the chosen azimuth. The metal detector is used to locate the rods at the 25, 50, 75, and 100-m points and the tape is clipped to them.

*Plot Location Notebook Updates*

The plot location maps must be updated to reflect any changes in landmarks since the original maps were drawn. Greater detail may have to be added to compensate for the loss of landmarks (such as a specific tree). Lost or damaged stakes are replaced. If the appearance of the area has changed markedly, photographs are taken to replace those in the Plot Location Notebook to aid in relocating the plot. Regardless of apparent changes, a panoramic photograph of the plot is always taken while standing directly over the beginning stake. This photo can be compared to the panoramic photograph taken at the time of initial inventory. All photographs are recorded on a Photo Log (Figure 11).

*Land Use Form*

The Land Use Form (Figure 17) is completed in the same manner as during the initial inventory, documenting conditions as they exist on the 6 x 100-m plot.

*Line Transect*

Data are gathered on the line transect using the point-intercept method as in the initial inventory, except in lesser detail. At 1-m intervals, beginning at the 0.5-m point, the tip of the 1-m measuring rod is used to determine the presence and type of disturbance. This is entered onto the Short-Term Monitoring Line Transect form (Figure 28) using the same codes as in the initial inventory (Table 4). Ground cover is recorded using codes from Table 11. Plant species identification is not necessary for Short-Term Monitoring. The presence or absence of canopy cover at any height is determined for each point and recorded as shown in Table 11.

*Belt Transect*

Rather than recording the location and height of each woody plant as in the initial inventory, Short-Term Monitoring of the belt transect entails only a tally of each species by 1-m height classes up to 4 m, and a single class for plants higher than 4 m. The same transect width and minimum height specified in the initial inventory must be used. Dead but rooted plants are recorded separately, by species and height class. The data form is illustrated in Figure 29.

LAND CONDITION TREND ANALYSIS
Short-Term Monitoring
Line Transect

Installation ____________________
Plot Number ____________________
Date ____________________

Disturbance N, R, T, P, O
Ground Cover B, L, R, P, M
Canopy N, A, and/or P

| Tran. Loc. | Dist. | Cov. | Can. |
|---|---|---|---|
| 0.5 | | | |
| 1.5 | | | |
| 2.5 | | | |
| 3.5 | | | |
| 4.5 | | | |
| 5.5 | | | |
| 6.5 | | | |
| 7.5 | | | |
| 8.5 | | | |
| 9.5 | | | |
| 10.5 | | | |
| 11.5 | | | |
| 12.5 | | | |
| 13.5 | | | |
| 14.5 | | | |
| 15.5 | | | |
| 16.5 | | | |
| 17.5 | | | |
| 18.5 | | | |
| 19.5 | | | |
| 20.5 | | | |
| 21.5 | | | |
| 22.5 | | | |
| 23.5 | | | |
| 24.5 | | | |

| Tran. Loc. | Dist. | Cov. | Can. |
|---|---|---|---|
| 25.5 | | | |
| 26.5 | | | |
| 27.5 | | | |
| 28.5 | | | |
| 29.5 | | | |
| 30.5 | | | |
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| 32.5 | | | |
| 33.5 | | | |
| 34.5 | | | |
| 35.5 | | | |
| 36.5 | | | |
| 37.5 | | | |
| 38.5 | | | |
| 39.5 | | | |
| 40.5 | | | |
| 41.5 | | | |
| 42.5 | | | |
| 43.5 | | | |
| 44.5 | | | |
| 45.5 | | | |
| 46.5 | | | |
| 47.5 | | | |
| 48.5 | | | |
| 49.5 | | | |

Page 1

**Figure 28. Short-Term Monitoring Belt Transect Form.**

**Table 11**

**Categories of Ground Cover and Canopy Cover Recorded During Short-Term Monitoring of LCTA Plots**

| Category | Code | Description |
|---|---|---|
| **Ground Cover** | | |
| Bare ground | B | Exposed soil |
| Rock | R | Any rock or gravel ≥ 2 mm |
| Litter | L | Any detached plant parts, including dead wood |
| Plant | P | Any attached part of a rooted vascular plant |
| Microphyte | M | Any moss, lichen or algae |
| **Canopy Cover** | | |
| None | N | No canopy cover above the point |
| Annual | A | Only annual and/or biennial plant cover above the point |
| Perennial | P | Only perennial plant cover above the point |
| Both | A/P | Both annual and perennial plants above the point |

*Wildlife*

Short-term wildlife monitoring consists of annual song bird censuses following procedures described for the initial plot inventory. This provides a minimum level of wildlife information to assess any trends and the relationship of wildlife trends to land use and habitat change.

## Long-Term Monitoring

Every 3 to 5 years, a complete Long-Term Monitoring resurvey of the plots is conducted. This is the basis for documenting overall change in the condition of Army installation natural resources. This monitoring is identical to the initial inventory in the reading of the line and belt transects, and surveying wildlife. However, it proceeds more quickly because the stakes are already established, no maps need be drawn (other than updating existing maps), no soil samples are taken, and no topographic measurements are taken. Species identification is facilitated by reference to data from the initial inventory and the laminated plant collection.

The plot is relocated in the same fashion described for Short-Term Monitoring. Maps are updated and stakes are replaced as necessary. A panoramic photograph of the plot is taken while standing at the beginning stake, and the photograph is logged. The Land Use Form is completed, the line and belt transects inventoried, and standard bird and small mammal data collected according to procedures described for the initial inventory.

LAND CONDITION TREND ANALYSIS
Short-Term Monitoring
Belt Transect

Installation ____________ Transect Width (m) 1___2___4___6___

Plot Number____________ Except ____________

Date____________ Minimum Height (m)_____0.1_____1.0

| Species | Height (meters) | | | | |
|---|---|---|---|---|---|
| | Min-1.0 | 1.0-2.0 | 2.0-3.0 | 3.0-4.0 | >4.0 |
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Figure 29. First Page of the Short-Term Monitoring Line Transect Form.

## 6 CONCLUSION

This report outlines methods that evaluate the capability of land to meet the multiple-use demands of the U.S. Army on a sustained basis through short- and long-term monitoring. By establishing representative core and special plots, it is possible to monitor changes in land resource condition and to evaluate change in terms of current land use. Data from regular monitoring of established field plots can be used to characterize installation natural resources and delineate biophysical and regulatory constraints to use of the land. Implementing standards in collection, analysis, and reporting will make Army-wide data compilation feasible. Over time, this recordkeeping system will provide the information needed to develop and refine land management plans that ensure long-term resource availability.

**METRIC CONVERSION TABLE**

| | | |
|---|---|---|
| 1 in. | = | 25.4 mm |
| 1 ft | = | 0.305 m |
| 1 acre | = | 0.4047 hectare |
| 1 gal | = | 3.78 l |

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